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SILVICULTURE OF MIXED CONIFER FORESTS

IN THE SOUTHWEST

by Frank Ronco, Jr., Gerald J. Gottfried, and Robert R. Alexander

USDA Forest Service
Rocky Mountain Forest and Range Experiment Station
FORT COLLINS, COLORADO

RM-TT-6

PREFACE

Mixed conifer forests in the Southwest cover about 2 million acres in Arizona, New Mexico, and Colorado. These forests consist of stands of from two to all eight of the following species:

Ponderosa pine (*Pinus ponderosa* var. *scopulorum* Engelm.)
Southwestern white pine (*Pinus strobiformis* Engelm.)
Blue spruce (*Picea pungens* Engelm.)
Engelmann spruce (*Picea engelmannii* Parry ex. Engelm.)
Corkbark fir (*Abies lasiocarpa* var. *arizonica* (Merriam) Lemm.)
White fir (*Abies concolor* var. *concolor* (Gord. & Glend.) Lindl. ex. Hildebr.)
Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco)
Quaking aspen (*Populus tremuloides* Michx.)

Because of the great range in species composition, as well as shade tolerance, windfirmness, stand conditions, seed production capabilities, habitat types, vulnerability to insects and diseases, and environmental factors, these forests are among the most complex that foresters must manage. But at the same time, their complexity offers more management flexibility than do pure stands.

It is important, therefore, that silvicultural practitioners and forest managers understand the interrelationship of these factors in order to choose the proper silvicultural treatment for a given stand. As you use these guidelines, think through your prescriptions carefully. Make sure that you select the right method to encourage the type of regeneration that will meet your management objectives.

This booklet and the accompanying slide-tape presentation are designed to provide a concise summary of the ecology and silviculture of mixed conifer forests in the Southwest. Note that the booklet includes the script (in regular type) and additional guidelines (in italic type). Whether you use this booklet alone or in a group training session, you'll find the discussion questions and programmed instruction sections helpful in adapting the material to your situation.

Please keep this booklet as a handy reference to help you recall the subjects presented in the talk and also to locate additional literature covering the original research. You can obtain copies of most of the references cited by contacting Publications Distribution at 240 West Prospect, Fort Collins, CO 80526-2098.

This slide-tape presentation has been distributed to all National Forests in the Southwest which manage mixed conifer forests. Information concerning the purchase of additional copies of this or other slide-tape and booklet sets in this series can be obtained from the USDA Forest Service Rocky Mountain and Southwestern Regional Offices, or by writing:

Public Affairs Officer
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Rocky Mountain Forest and Range Experiment Station
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Silviculture of Mixed Conifer Forests in the Southwest

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1

2

3

4

1. . .**2**. . .**3**. . .(musical interlude)

4. Is there such a thing as a **single** "mixed-conifer" type?

4

5

6

7

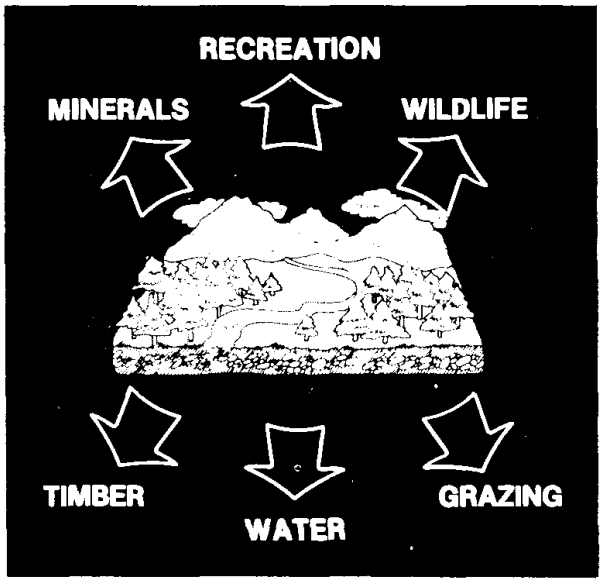
5. Where do you find these stands? . . . and how did they develop there?

6. What information do I need to manage them properly?

7. The Southwest's mixed-conifer forests provide valuable timber, . . .

8. . . . wildlife, water, and recreation resources sought by so many.

8



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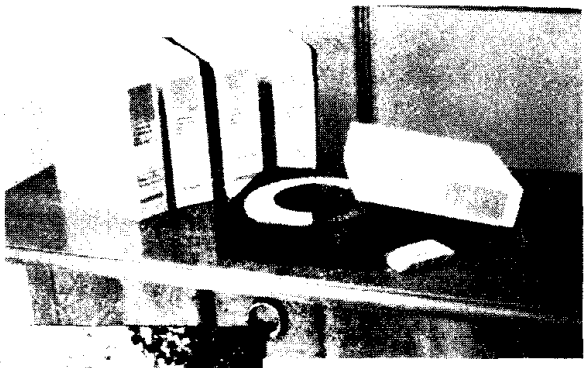

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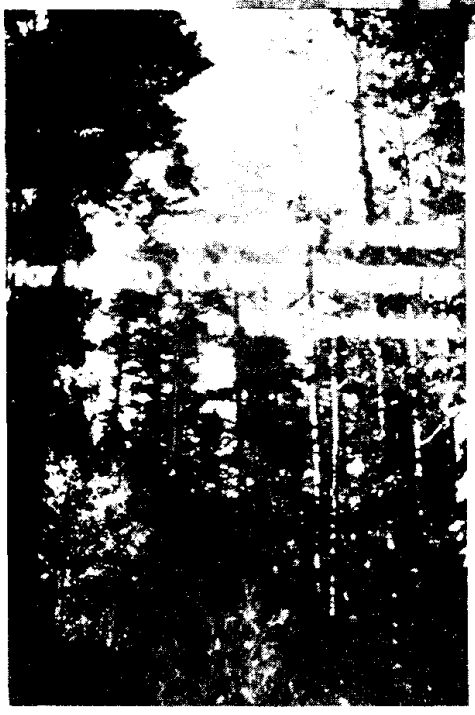

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9. Today, you must manage complex stands like these to meet increased demands for limited forest resources. And you must do so without damaging the environment.

10. This program is one of a series designed to help foresters manage each of the major forest zones in the central Rockies and Southwest (Shepperd and Alexander 1983 a,b,c; Shepperd et al 1983). The introductory "Overview" program covered the basics. The companion programs discussed silviculture of several major species. Now let's look at the. . .

11. . . . silviculture of the Southwest's mixed conifer forests.

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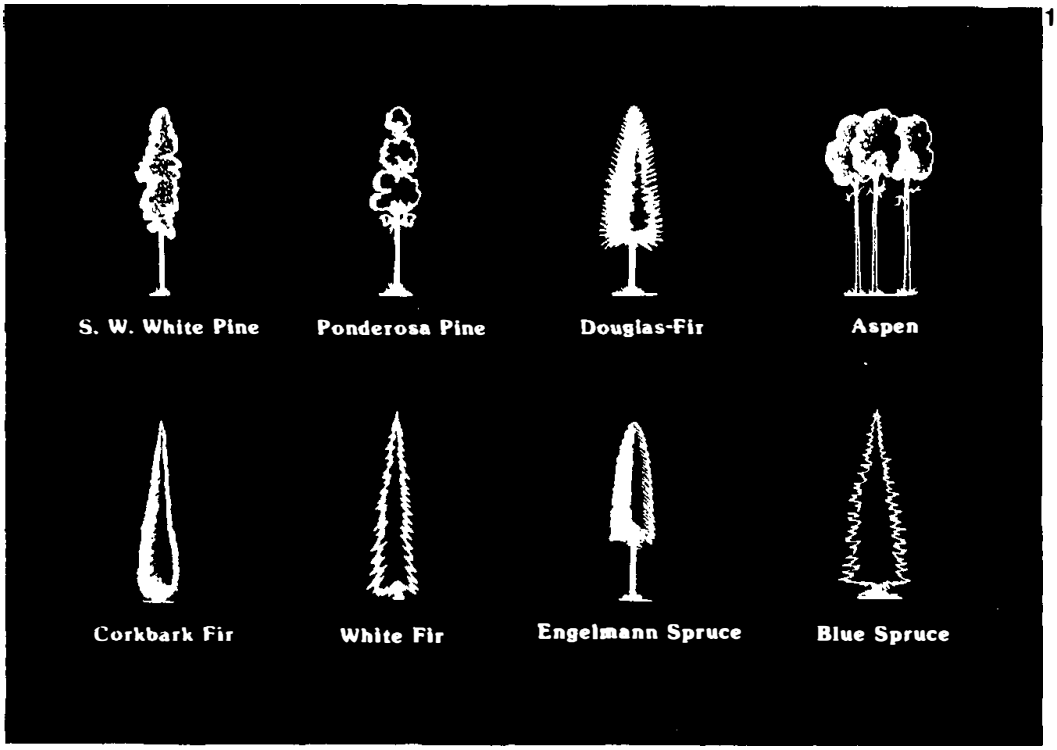
SILVICS OF MIXED CONIFER STANDS

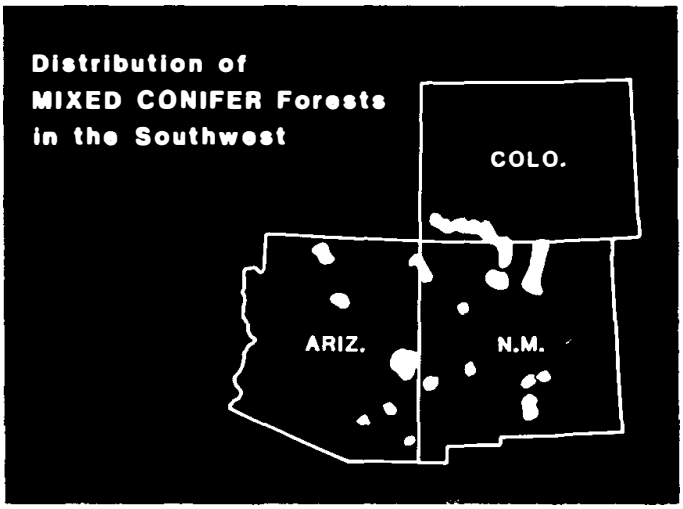
SPECIES COMPOSITION



13. The term "mixed conifer forests" describes forests that are composed of mixed species, rather than pure stands of one or two species. They can include from two to all eight of the tree species shown. But notice that not all of them are conifers.

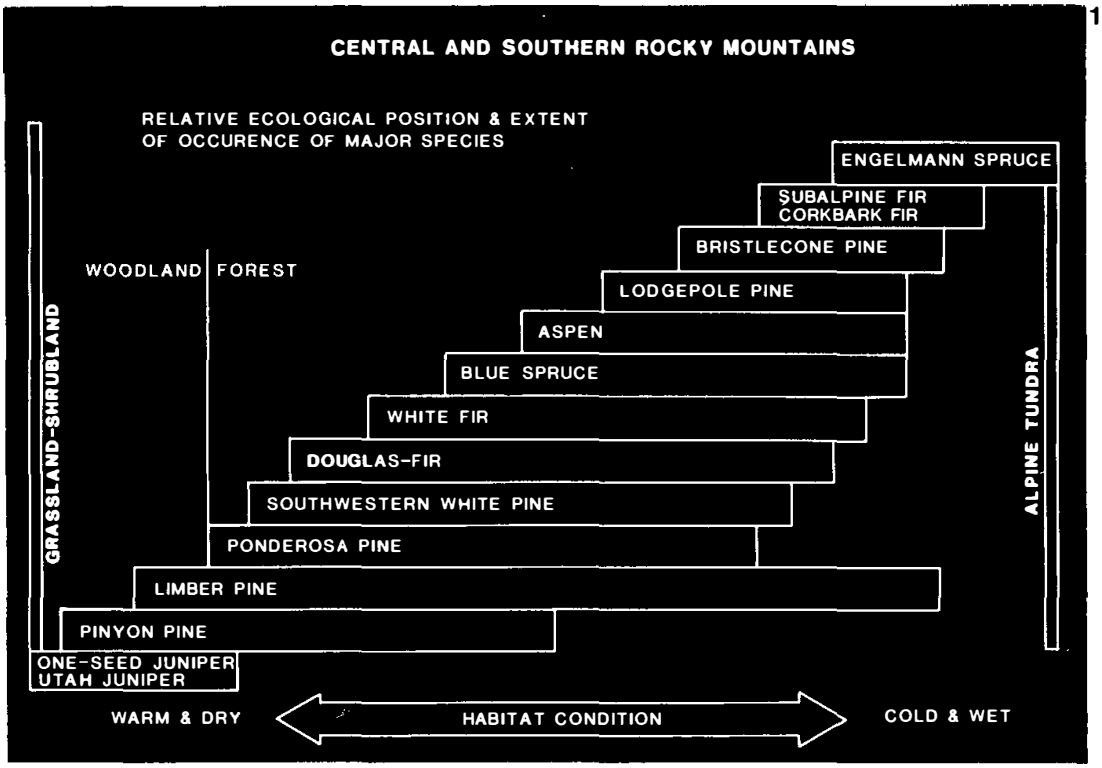
These stands are not officially recognized by the Society of American Foresters as a forest cover type (Society of American Foresters 1980).

ECOLOGICAL DISTRIBUTION



14. Mixed conifer forests cover about 2 million acres in Arizona, New Mexico, and southwest Colorado (Jones 1974).

15



15. *Here you see the relative ecological position of southwestern species in relation to elevation, moisture and temperature.*

You'll find the eight mixed conifer species at higher elevations on wetter sites than pure ponderosa pine, and on warmer sites than those for Engelmann spruce-corkbark fir stands.

TOLERANCE

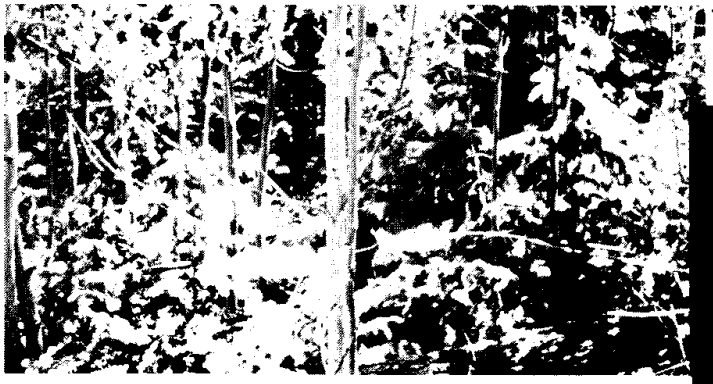
16

RELATIVE TOLERANCE

VERY INTOLERANT	INTOLERANT	MODERATELY INTOLERANT	TOLERANT	VERY TOLERANT
Aspen	Lodgepole pine	Blue spruce	Engelmann spruce	Subalpine fir
Bristlecone pine	Pinyon	Douglas-fir	White fir	Corkbark fir
Limber pine	Ponderosa pine			
	Southwestern white pine			

16. The stand composition reflects shade tolerance of the eight species involved (Ronco et al 1983). The differences in shade tolerance. . .

SUCCESSION



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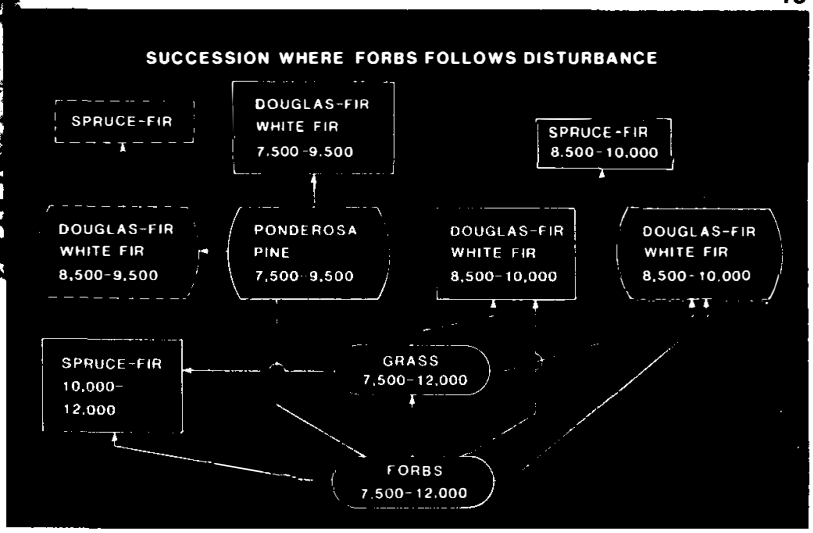
17. . . . cause a lot of variation in the initial stages of the developing stands; but with time, they move toward climax forests of either. . .

18



(Broken lines indicate speculative successions.)

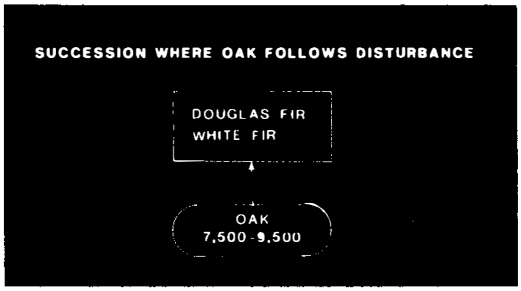
18. . . . Engelmann spruce-corkbark fir, or Douglas-fir-white fir, depending on the elevation and aspect (Jones 1974). But on moist sites, the climax may be blue spruce.

Most mixed conifer stands seem to have developed following wildfire.

When the initial successional stage is forbs, the successional paths depend on the conifers available as seed sources.

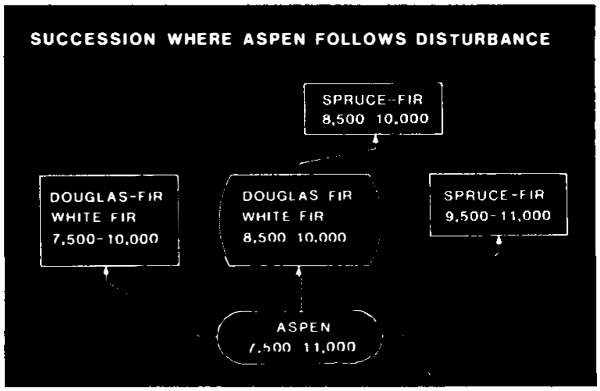
When grass gets established, it slows down the reestablishment of conifers.

19



19. Oak may also be the initial stage and can maintain itself for a long time.

20. When the initial stage is aspen, its persistence depends on whether or not a coniferous seed source is present. Tolerant conifers easily replace aspen.



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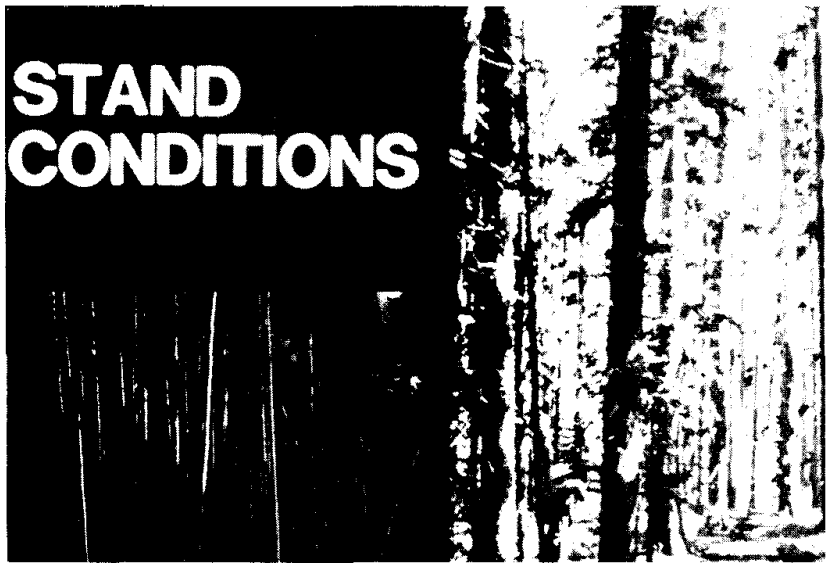
- STAND CONDITIONS
- INITIAL ESTABLISHMENT
- DAMAGING AGENTS
- REGENERATION SILVICULTURE
- CUTTING GUIDELINES
- CUTTING MODIFICATIONS

21. So far, we've looked at some ecological aspects of mixed conifer stands. We'll now discuss these additional aspects that influence your prescriptions for these stands.

STAND CONDITIONS



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22. There is a lot of variation in the conditions, characteristics, and potential responses of stands, so this complicates your choice of silvicultural systems and cutting methods. But at the same time, that variability gives you more management options than with pure stands.

TREE DISTRIBUTION

23

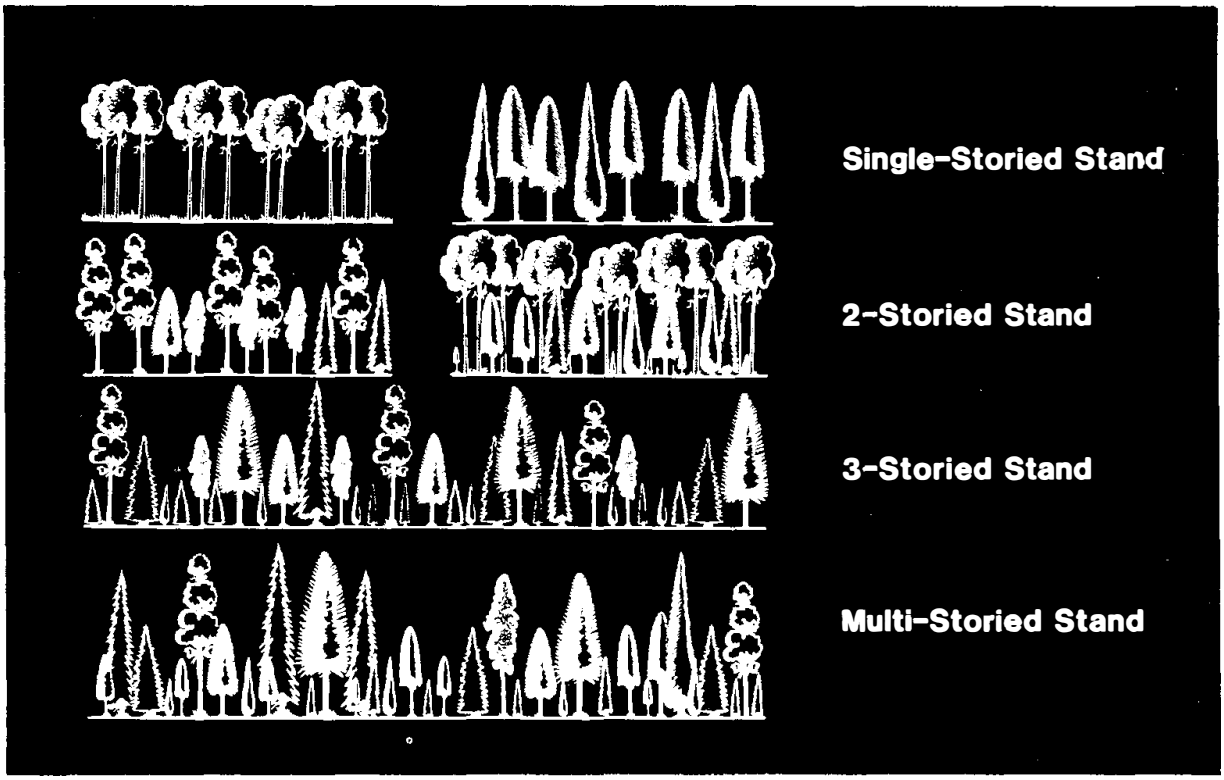
24

23. Mixed conifer stands may be uniformly spaced...

24. ...or in groups with similar characteristics, giving the stand a clumpy appearance.

Your stand inventory should be detailed enough to provide you with this information when you're developing a stand prescription.

STAND STRUCTURE



25·26·27·28

25. The stands can occur with one or more stories (Jones 1974). But single-storied stands are not common. The ones you do find usually have trees that are uniformly spaced, with no manageable stands of advanced reproduction.

26. Although two-storied stands are also uncommon, their management presents some difficult problems; but we'll discuss these later.

They're likely to have uniformly stocked overstories of ponderosa pine or aspen, and understories of more tolerant species.

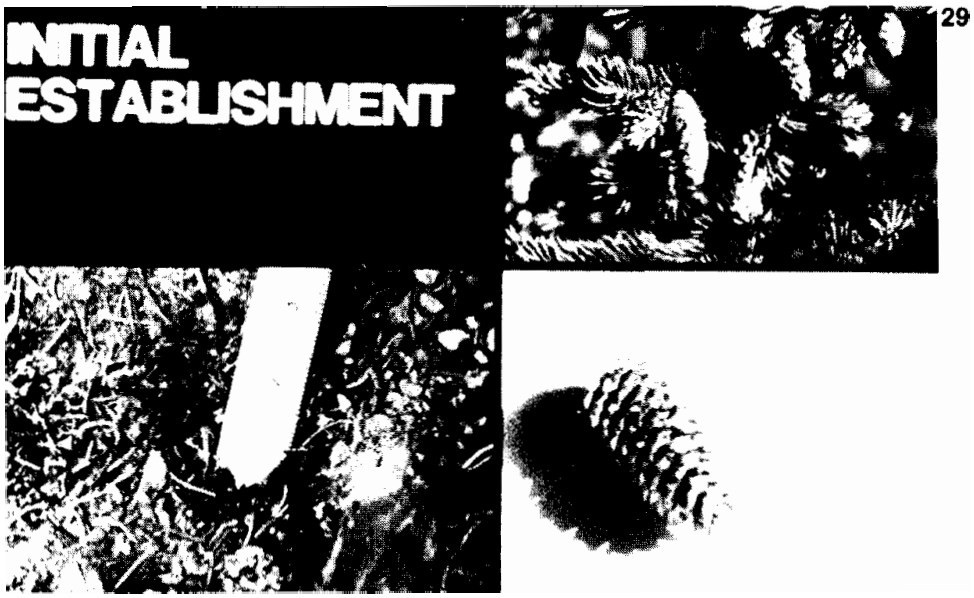
27. The more common three-storied stands are usually more clumpy than single- or two-storied stands. This is because some originated from partial **cutting** in two-storied stands, and others from the natural **deterioration** of two-storied stands.

They usually have a manageable stand of advanced reproduction of tolerant species.

28. Multi-storied stands are by far the **most** common. Douglas-fir usually dominates the overstory, while white fir or Engelmann spruce and corkbark fir make up the younger age classes.

The age and size classes are often grouped. There's usually a manageable stand of advanced reproduction, which normally doesn't include ponderosa pine.

INITIAL ESTABLISHMENT



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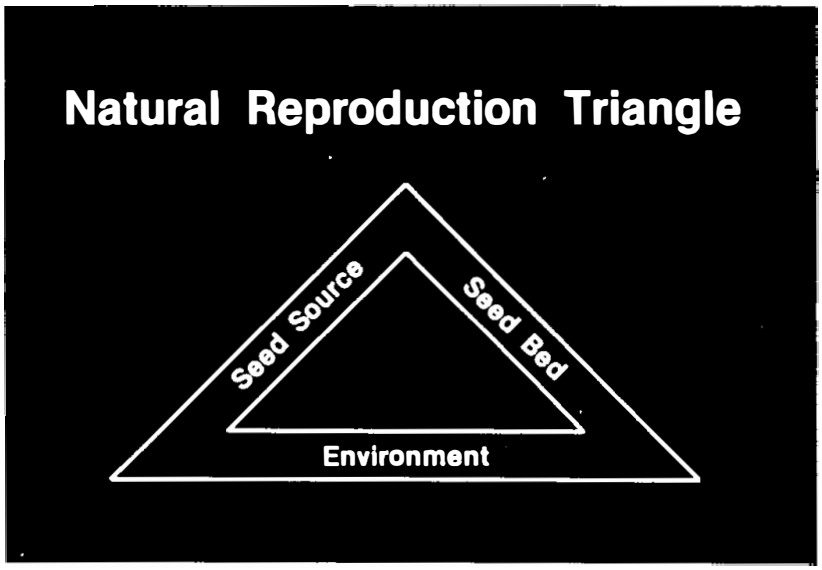
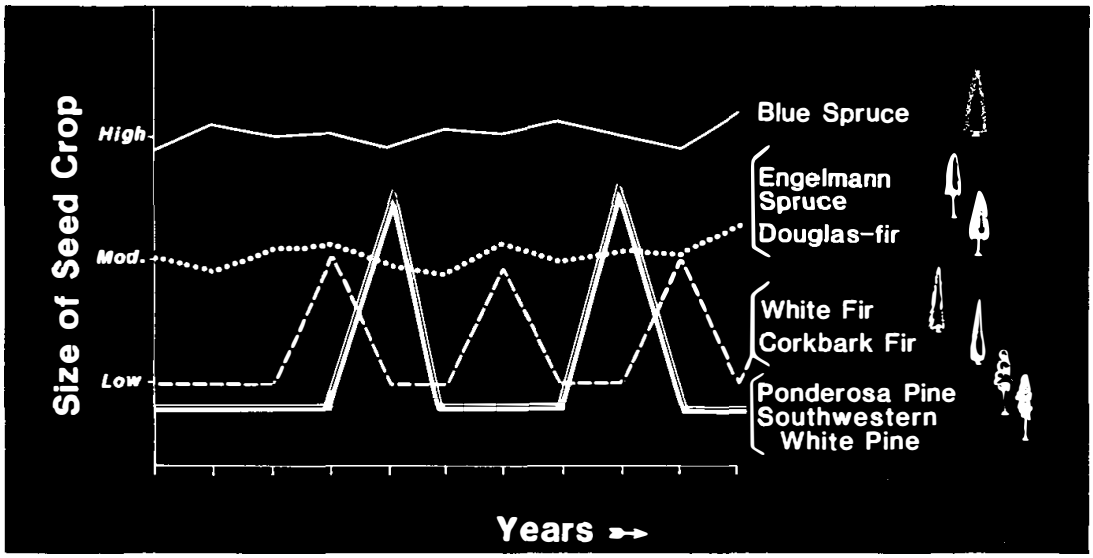
29. When you're writing a prescription, remember the regeneration characteristics of each of the eight species. Of the three...

30



30. ...critical needs in the regeneration triangle (Roe et al 1970), the "Overview" program explained the seedbed. We'll now discuss the **seed source** and **environmental** factors.

SEED SOURCE



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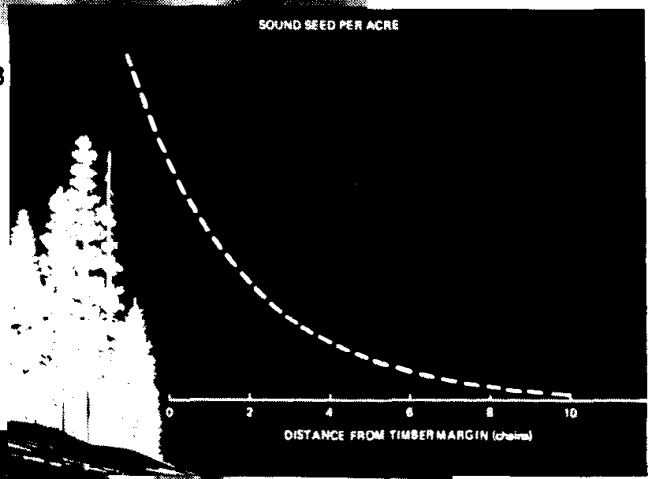
31. As you can see, some conifers are reliable seed producers, and others are sporadic; some produce heavy crops, while the crops of others are moderate to light (Ronco et al 1983).

32



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34

32. Seed characteristics are critical, too. Southwestern white pine produces wingless seeds, that essentially fall straight down from the tree's crown (Krugman and Jenkinson 1974).

33. But the seeds of the other conifers have wings and are spread by the wind. Most seed falls within 3 chains (or 200 ft.) of the windward timber edge (Ronco et al 1983). Beyond 200 ft., seedfall diminishes rapidly. So if you plan to use natural regeneration, limit the size of your openings.

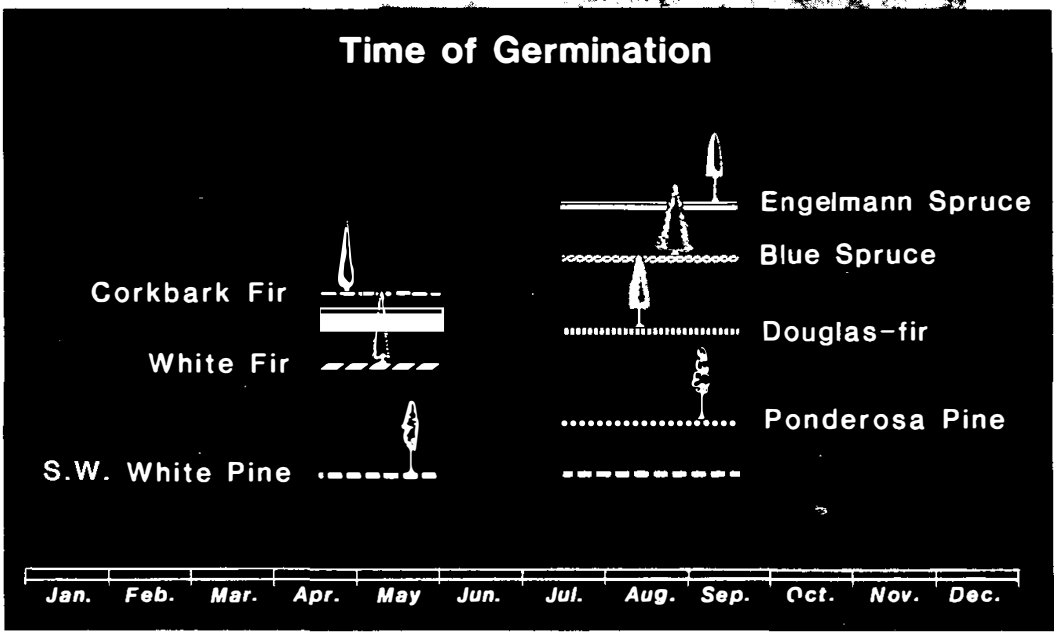
34. Although aspen produces millions of seeds, not many of them ever germinate because the Southwest lacks suitable moisture and mineral soil seedbeds (Shepperd and Engelby 1983).

ENVIRONMENT
GERMINATION & SUCKERING

35

35. In addition to a reliable seed source and suitable seedbed, seeds need a compatible **environment** to germinate and become established.

36



37

36. Seeds need a constant supply of moisture to germinate. Here we see seasonal differences in germination between the conifers; some rely on snowmelt and others on summer rains for their moisture (Jones 1974).

37. Aspen reproduces mainly by suckering. When the soil is exposed to sunlight, it warms up and root temperatures increase. This stimulates suckering.

38

38. But the apical dominance of overstory aspen inhibits suckering (Jones 1974). So, you only get abundant reproduction when the existing stand is cut or treated, allowing sunlight to reach the soil.

SEEDLING SURVIVAL

39

40

41

Light

39. In the case of conifers, as seedlings develop, their survival depends on other environmental factors, such as light intensity. Higher elevations and certain cloud covers produce extremely high light intensities that damage seedlings such as this young Engelmann spruce (Ronco 1970a). As it grew beyond its protective shade...

40. ...its terminal leader and lateral branches were exposed to full sun. This...

41. ...produced chlorotic or yellowed needles on foliage exposed to the sun. The true firs and Engelmann spruce are especially susceptible (Jones 1974).

If they're not shaded early in their life, up to 85% of the seedlings can die within the first two years (Ronco 1970b).

42

Drought

42. Then there's drought. It's a greater threat to true firs and spruces, with their shallow and slow growing root systems. Since the roots of pines and Douglas-fir grow faster, they can survive dry spells better. But they **also** can be killed by drought (Embry 1971, Jones 1971, 1972).

43

Shade

43. Shade, such as provided here by logging slash, is critical for many species, especially on south-facing slopes where heat, dryness, and intense sunlight spell death for vulnerable species.

Frost Heaving

44. Shade also reduces frost heaving. It prolongs snow cover, which reduces the daily thawing of bare ground. Frost heaving occurs...

44

45. ...when ice lenses lift the surface of the soil, which is frozen tightly to the stem. This action pulls the seedling up out of the soil.

Frost heaving is more of a problem in volcanic than sedimentary soils, because of their higher silt content (Heidmann and Thorud 1976).

45

Frost Injury

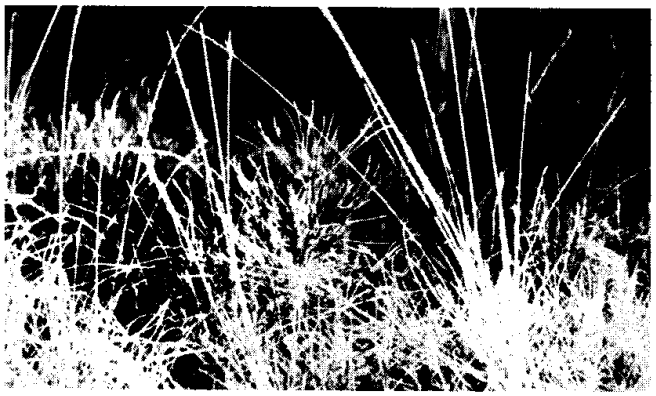
46. Frost may also kill tender new growth on seedlings, unless they're protected by logs or other cover (Ronco 1967).

True firs and spruces are more susceptible to frost injury than pines.

Grass Competition

47. On warmer, drier sites, grass competes with seedlings for moisture (Embry 1971). A thick grass cover, when it's cured, can bury seedlings under a dense mat (Jones 1974).

46



47

DAMAGING AGENTS

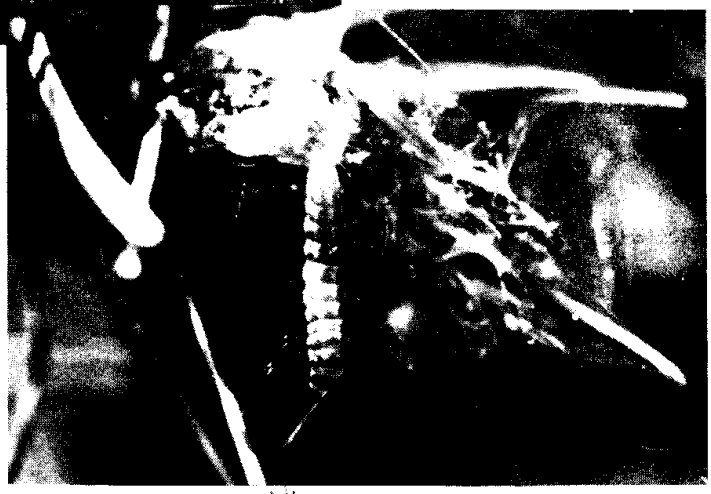
48

48. Besides environmental factors that threaten seedlings, many agents can damage or kill **mature** trees.

INSECTS

49

49. One of these is insects. The most serious insect pests are the defoliators: western spruce budworm and western tent caterpillar (Jones 1974). Bark beetles are less of a problem, because the mixture of species in these stands dilutes the number of potential host trees.



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50. Western spruce budworms infest stands of true firs and Douglas-fir, and to a lesser extent, Engelmann spruce. But true firs suffer more damage.

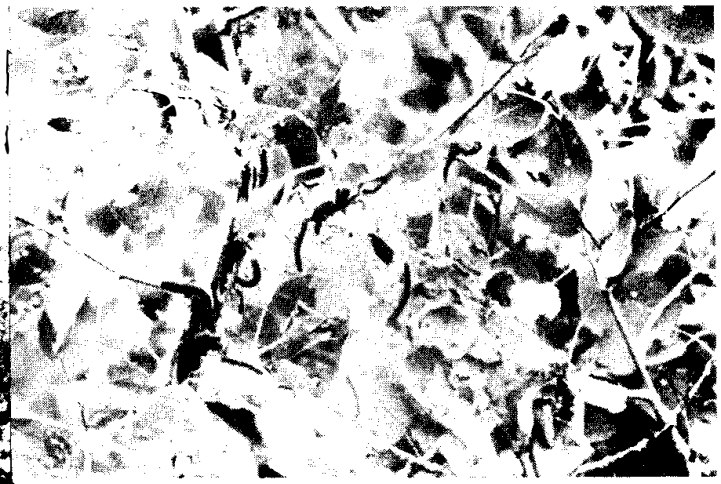
This is a special problem in multi-storied stands where the larvae drop from the canopy to understory trees.

51. Outbreaks cause top kill, and the dead leaders act as decay centers. Although budworm defoliation slows tree growth, it usually won't kill mature trees unless they are severely defoliated for several years in succession (McKnight 1968).

But seedlings are affected to a greater extent.

51

52. The second major insect, the western tent caterpillar, infests aspen stands (Jones 1974, Stelzer 1968).



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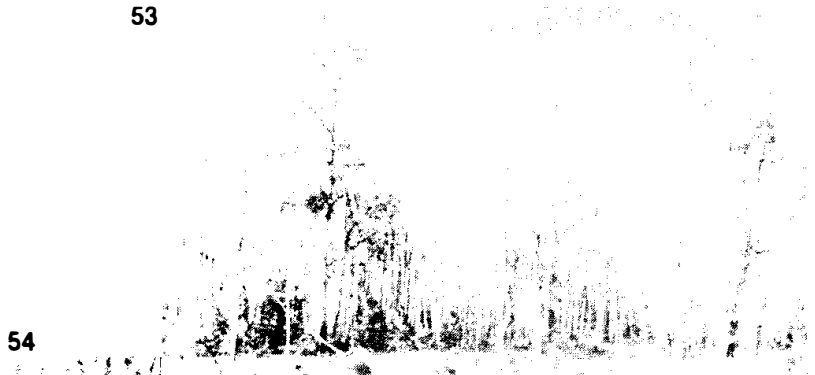

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55

56

57

53. Outbreaks can last for several years. They greatly slow growth and can destroy stands if natural causes don't stop the outbreak.

54. Mountain pine, spruce, and Douglas-fir beetles usually attack overmature trees (Schmid and Frye 1977). Outbreaks of spruce and Douglas-fir beetles may...

55. ...develop in heavy blowdown, or...

56. ...in concentrations of large-diameter logging slash.

57. The best way to handle outbreaks is to remove attacked and susceptible trees within the limits specified by the guidelines on windrisk for the particular stand. All infested material should be burned or chemically treated according to Regional policy.

If there are many small diameter trees, leave them. Otherwise, plan to regenerate a new stand.

DISEASE

58

58. Diseases damage trees, too (Jones 1974). They're one major reason for minimizing logging damage. Among those fungi that attack aspen, trunk rot and cankers are the most damaging. Because injuries allow diseases to easily enter aspen and true firs, be especially careful when making partial cuts in these stands.

59

59. Dwarf mistletoes, another major group of diseases, infect trees of all ages and cause growth loss and premature mortality (Hawksworth and Wiens 1972). Because each mistletoe species is host specific, it's usually worse in pure stands than in stands with mixed species.

It can be especially bad in stands with a high proportion of either ponderosa pine or Douglas-fir (Gottfried and Embry 1977).

60

60. Dwarf mistletoe drastically reduces the growth of older, larger trees, and they die slowly. It's most damaging in stands partly opened by cutting, bark beetles, or windfall, because the openness allows it to spread faster.

Regenerated burns seem least affected.

BIRDS & MAMMALS

61

BROWSE PREFERENCE
of
BIG GAME & LIVESTOCK

Desirability			
Highest	High	Moderate	Low
Aspen	[illegible]	[illegible]	[illegible]
	White Fir		Engelmann Spruce
	Corkbark Fir		Blue Spruce

62

63

64

65

61. Animals also take their toll (Jones 1974). Although big game and livestock browse **all** conifers and aspen, they have...

62. ...definite preferences, as shown here.

63. And they trample young trees.

64. On the other hand, birds, squirrels, and other mammals eat large amounts of seed and some even eat seedlings (Noble and Shepperd 1973, Roe et al 1970).

65. Mice and pocket gophers damage stems and root systems (Crouch 1982).

FIRE

66

66. Fire can be another damaging agent (Jones 1974). It mainly damages poles, saplings and seedlings. Crown fires are a constant threat. This is because the stands are dense, and because of the large amounts of surface and ladder fuels (Sackett 1979).

Older trees of species with thick bark, such as the pines and Douglas-fir, are quite resistant to surface fires. But intense fires will destroy all trees.

67. Trees scarred from intense wildfires have a lower market value and their trunks are more susceptible to decay (Embry and Gottfried 1971).

67

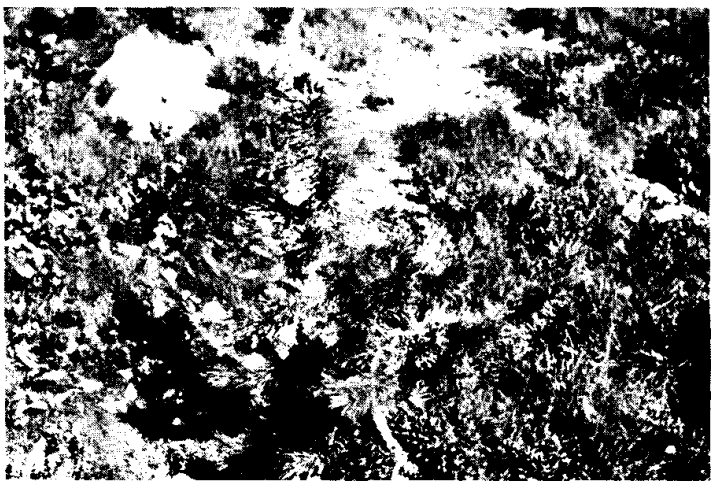
68. But on the other hand, low intensity prescribed fires may be a useful tool in managing mixed conifers. We don't have a lot of data yet, but we believe that fire can be used not only to reduce fuels, but also to alter species composition, prepare sites, sanitize stands, and create varied patterns of stands that benefit wildlife and other resources.

68

WINTERKILL

69. Winterkill is another damaging agent. It occurs when cold or frozen soils exist during warm, windy weather. This increases the rate of transpiration, and trees can actually die from drought.

Ponderosa pine and white fir are especially susceptible (Maul 1965, Schubert 1974).



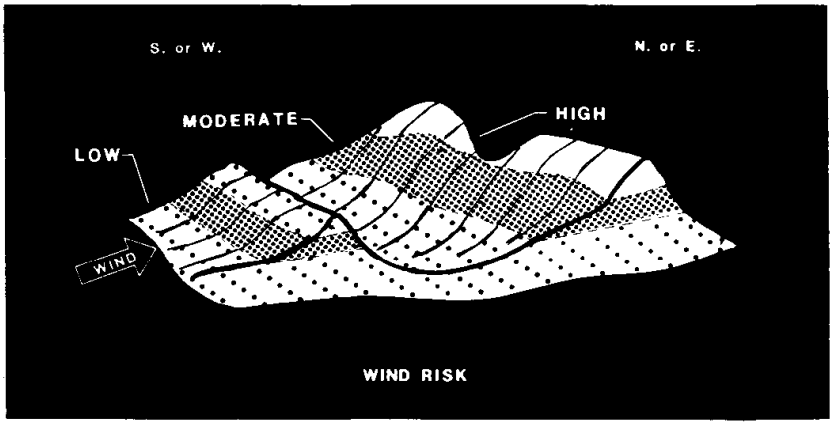
69

WIND

70

71

72·75·76



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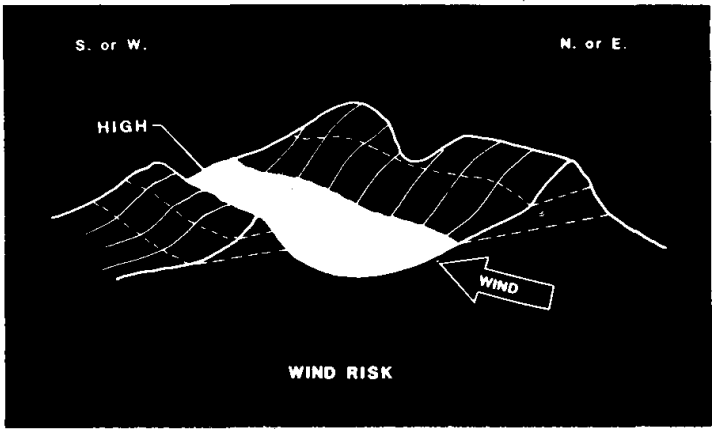


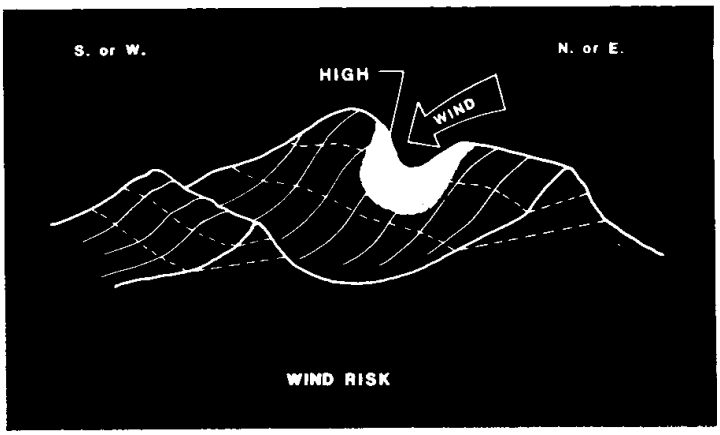
70. Wind at high elevations can lead to extensive blowdown, such as this area in northern New Mexico. Wind risk is related to stand conditions, cutting methods, soil depth and drainage, topographic exposure, and. . .

71. . . .rooting habit of species. Trees on shallow or poorly drained soils lack deep root systems and are easily windthrown, as are those with root rot. But trees with trunk rot **break** more easily.

72. Several guidelines can help you determine the wind risks of particular stands based on topographic features (Alexander 1964, 1967, 1974). For example, in this slide, south or west faces to the left, and north or east to the right. The red zones [ ] show high wind risk. These areas occur on all ridgetops, and on moderate to steep upper slopes that face south or west. If the low mountain on the left were not there, the high risk zone would also include mid-slopes further down the large mountain.

73. Other high wind risk areas include valley bottoms that are parallel to the wind,. . .

74



74. . . .and where wind is funneled through saddles in ridges.

75. The orange belts [▒▒▒]* indicate moderate (or above average) wind risk. These zones occur on lower and gentle slopes that face south or west. But they also occur on moderate to steep mid-slopes that face south or west if these slopes are **protected** by higher ground to the windward, such as the smaller ridge to the left. Risk is also moderate on mid- and upper-slopes that face north or east.

76. The beige areas [▒▒▒]* indicate low (or below average) wind risk, which are usually found on flat or more protected sites.

The first zone is in flat areas or valley bottoms at right angles to the wind; secondly on both lower and gentle middle slopes that face north or east, as shown toward the right; and finally, on lower and gentle middle slopes that face south and west and are protected by higher ground close to the windward side.

*(For 75 & 76, see art on p. 23.)

77

- **Environmental Factors**
- **Stand Conditions**
- **Initial Establishment**
- **Damaging Agents**

77. Up to this point, we've discussed these basic factors to consider when you develop prescriptions for mixed conifer stands. Before we discuss silvicultural systems that apply,. . .

78

Let's Review . . .

78. . . .let's take a break to review the material so far.

SUMMARY

When developing prescriptions for mixed conifer stands, you must consider: ecological aspects, stand conditions, initial establishment, and damaging agents.

Ecological Aspects include species composition, distribution, tolerance, and succession.

Mixed conifer forests include from two to all eight of these species: southwestern white pine, ponderosa pine, Douglas-fir, aspen, corkbark fir, white fir, Engelmann spruce, and blue spruce. But they are not considered an SAF forest type.

Mixed conifer stands occur on wetter sites than pure ponderosa pine stands, and on warmer sites than Engelmann spruce-corkbark fir stands.

Shade tolerances differ among the eight species from the very tolerant corkbark fir to the very intolerant aspen, causing a lot of variation in initial stages of succession.

Mixed conifer stands usually develop a climax of either Engelmann spruce-corkbark fir, Douglas-fir-white fir, or, on moist sites, blue spruce.

Stand Conditions vary greatly. Stands may be uniformly spaced or in groups having similar characteristics. Stands may occur with one or more stories, but multi-storied stands are most common.

Initial Establishment depends on seedbed, seed source, and environmental factors. Some conifers are reliable seed producers; others are not. Most seed is winged and spread by wind. Aspen reproduces by suckering.

The environmental factors affect germination and survival by their influence on drought injury, light injury, frost heaving, and frost injury. Competition from other vegetation is also a factor.

Damaging Agents are insects, diseases, wildlife, fire, winterkill, and wind.

79. Discuss these questions and their applications to your situations, back in your own units.

(For guidelines for discussing questions no. 79a, 79b, and 79c, refer to pg. 68.)

79a. Why is the management of mixed conifer forests both more complex and more flexible than for pure stands?

79b. In what ways do the factors influencing the management of mixed conifer stands differ from the factors considered when managing pure stands?

79c. Wind risk is related to species and site characteristics. What are they? What are the three topographic wind risk zones, and what are the characteristics of the highest risk zone?

79d. What are the primary environmental factors influencing seedling establishment and development on the sites on which you'll be working?

79e. In your area, what are the major damaging agents that can kill or injure mature trees? How serious is each threat? Rank the threats according to (1) their current seriousness and (2) potential seriousness as stands regenerate.

A. Review of Regeneration Silviculture

B. Cutting Guidelines

C. Cutting Modifications

80

80. Now, let's take a look at these three aspects of silvicultural systems for natural regeneration of mixed conifer stands.

REGENERATION SILVICULTURE

81

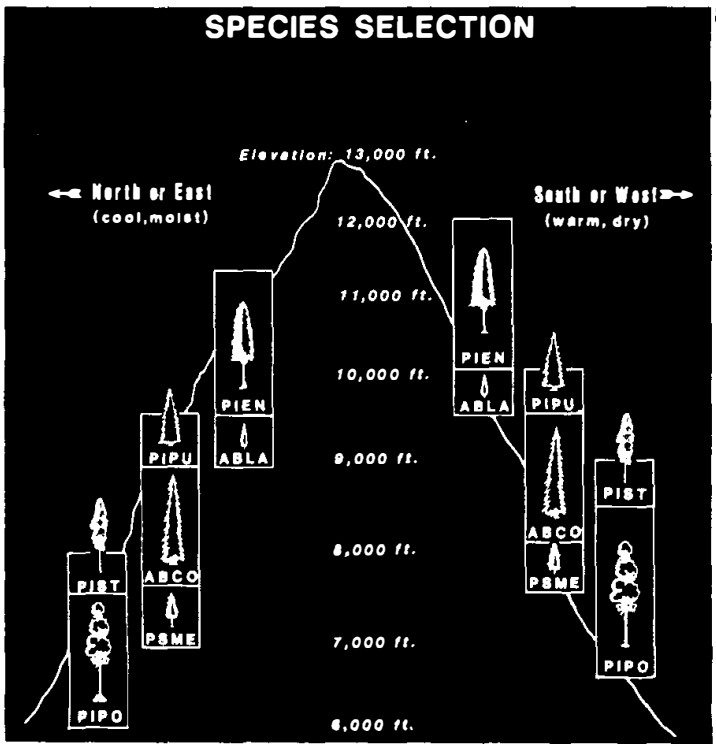
81. As you'll recall from the "Overview" slide-tape, any regeneration system aims to harvest the timber crop and get adequate reproduction. For mixed conifers, your decisions are more complicated because you're working with up to eight species with regeneration needs that differ.

82

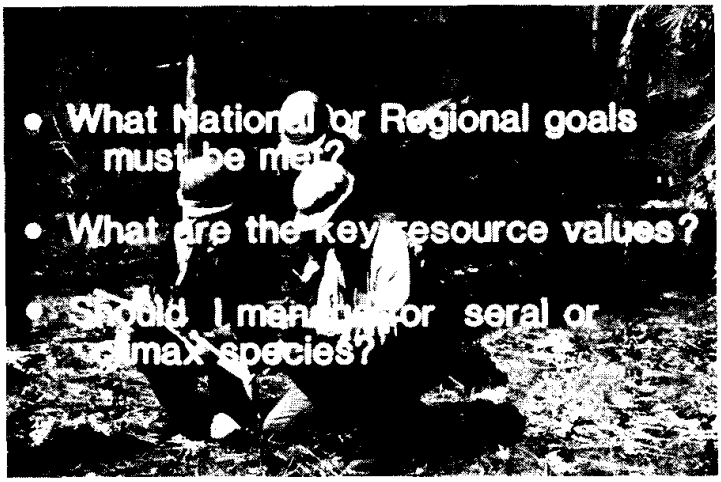
- Stand Composition
- Habitat Type
- Management Objectives
- Stand Conditions
- Tolerance
- Windfirmness
- Environmental Factors
- Regeneration Problems
- Susceptibility to Insects & Disease

82. The management approach you choose depends first of all on the existing composition of the stand, and also on the potential indicated by the habitat type. But when you're writing a prescription, you also must consider each factor shown here.

83



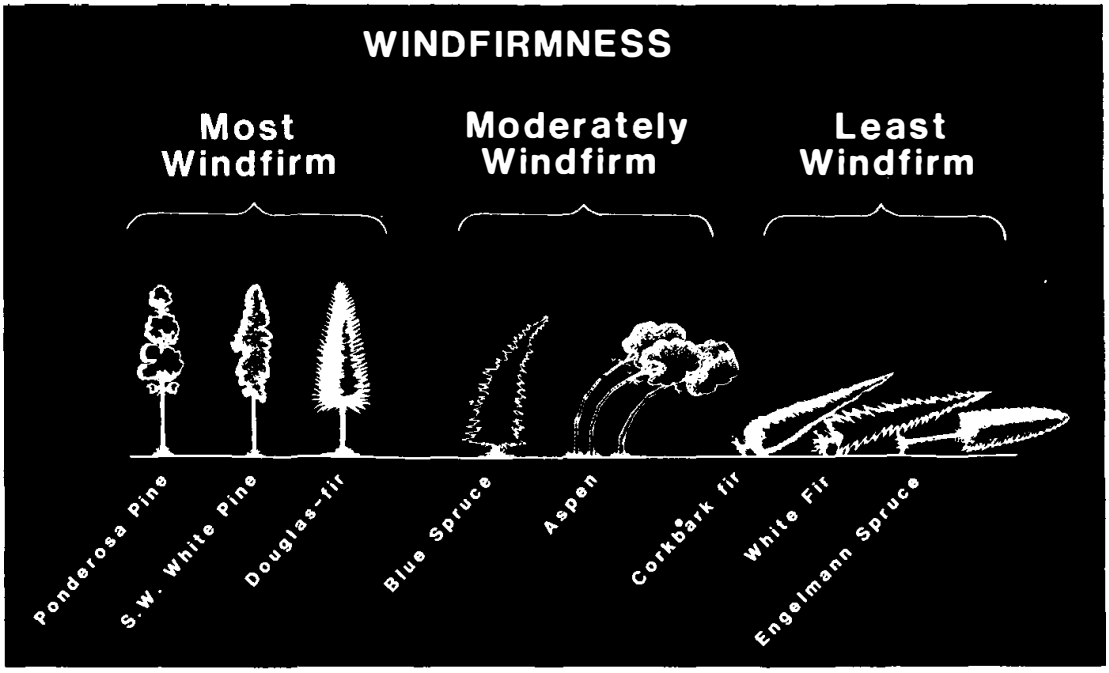
83. The first factor, stand composition, affects the species you choose to manage. You should generally manage for the more shade-tolerant, mesic species at higher elevations or on cool, moist sites. Manage for shade-intolerant, xeric species at lower elevations or on warm, dry sites (Jones 1974).



84

84. You must also consider management objectives to determine which species to favor. Is the regeneration produced by your prescription consistent with these objectives?

85



86

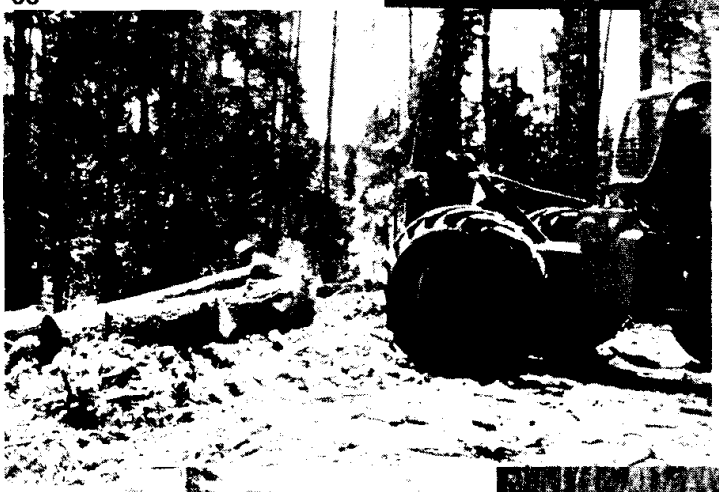
85. Next, consider relative windfirmness when you select the species you wish to retain or regenerate (Ronco et al 1983). This is especially true where there is a high wind risk.

86. Your ability to classify a site by habitat type also helps you select the best species to favor.

For example, ponderosa pine grows very well on some mixed conifer habitat types, so heavy cuts to favor it are appropriate. On some other habitat types, it does not. So lighter cuts to favor tolerant species may be more appropriate. Several Rocky Mountain Station publications on habitat type classification are, or soon will be, available to help you identify those types that are known and the management implications for each one (Alexander 1984 a,b; Hanks et al 1983; Moir and Ludwig 1979).

87

88



89

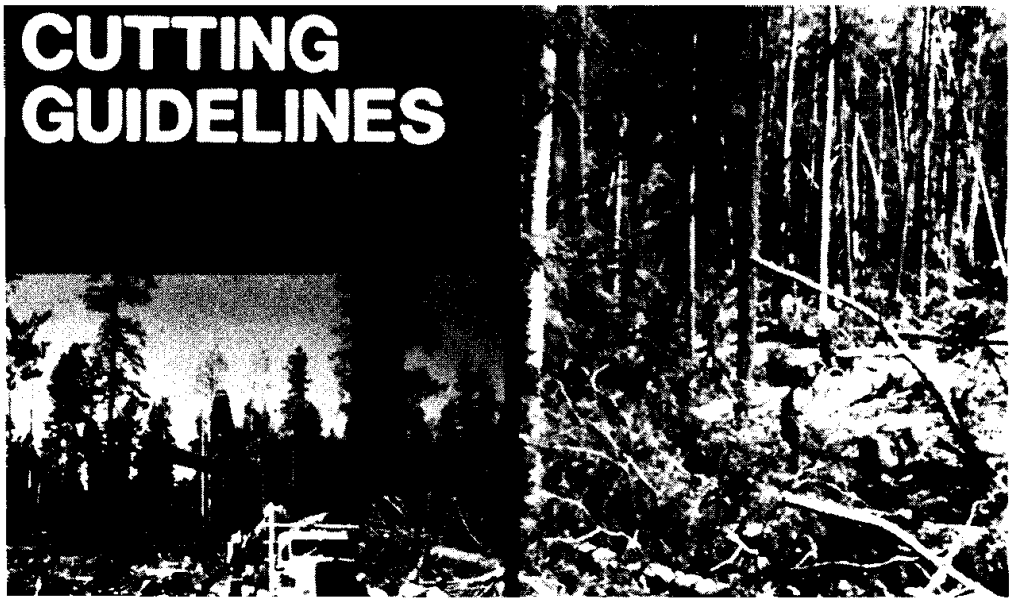
87. By now, you've probably concluded that managing mixed conifers is almost impossible. It's tough, but it's not impossible. We'll now outline a general approach to help you assess the silvicultural system . . .

88. . . . and cutting method to use. In practice, you can use both even-aged and uneven-aged systems and their respective cutting methods. But you must first consider management objectives and treat each stand individually.

89. You can use clearcutting, shelterwood, and selection cutting, and their modifications (Ronco et al 1983).

CUTTING GUIDELINES

90



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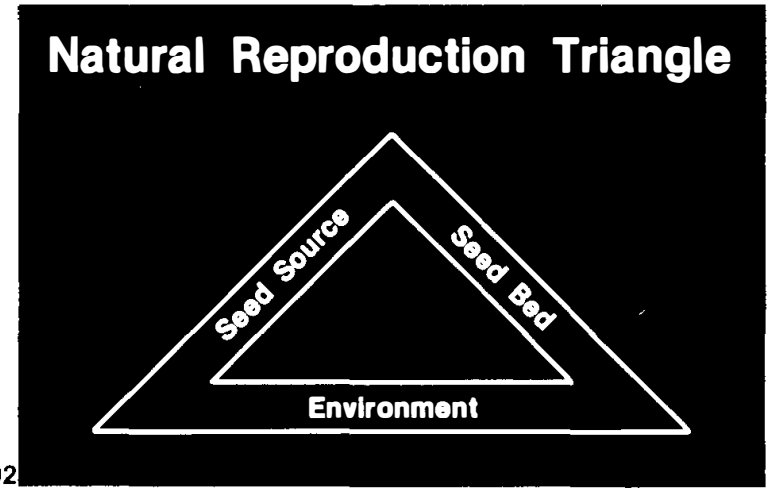
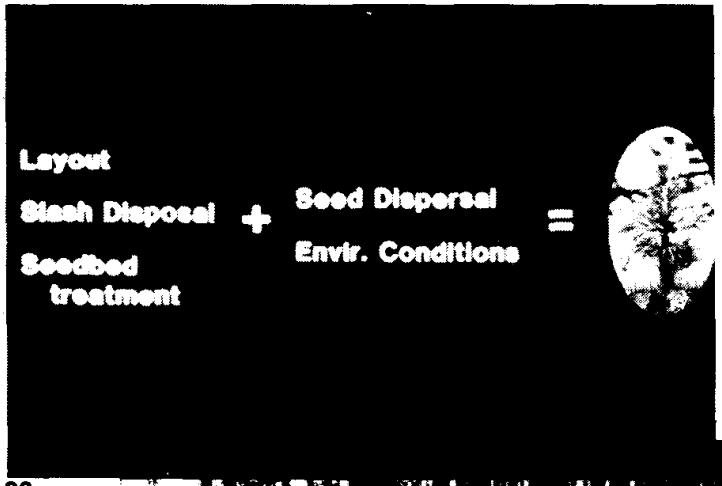


90. In order to bring some stands under management, you'll need a prescription that involves a combination of cultural practices. To restock the area, . . .

91. . . . first consider cultivating the existing advanced reproduction, shown here, and second, using natural or artificial means to restock after cutting. If you choose to use natural regeneration, . . .

92. . . . then you must provide all three elements of the regeneration triangle (Roe et al 1970). Let's look at the ways that the three elements apply to clearcutting.

CLEARCUTTING
CONIFERS



93

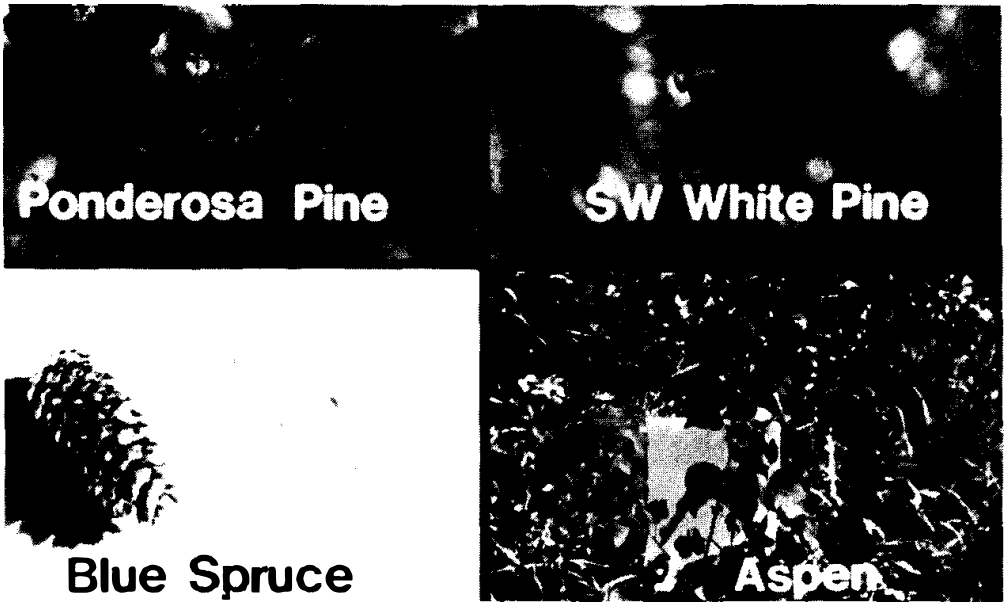
94

93. On clearcuts, you must specify layout of the unit, slash disposal, and seedbed treatments so that they provide for seed dispersal and create good conditions for germination and seedling establishment (Shepperd and Alexander 1983b). Remember, clearcutting favors less tolerant species.

94. Clearcuts must be small enough to ensure that all parts of the cut are within seed dispersal range of the desired species (Alexander 1974, Roe et al 1970). The size of clearcut openings will vary more than in other types of forests. This is because of wide differences in seed size and dissemination characteristics.

95. You can use larger openings if the seed source consists of small-seeded species (such as the spruces). But openings should be smaller for trees with larger seeds, such as true firs, Douglas-fir, or pines.

Remember, southwestern white pine seed is wingless and is not carried much beyond the crown limit. Conversely, the size of openings to be regenerated to aspen is limitless, because the species reproduces by sprouting.



95

96

96. The clearcut must be on aspects and of a size that provide adequate environments for seed germination, establishment, and survival.

97

97. Clearcutting on south and west slopes gives mixed results. The extreme environmental conditions may prevent successful establishment of species adapted to shade and cool, moist environments.

These include such species as Engelmann spruce, Douglas-fir, and true firs. Clearcutting tends to favor species that are not shade tolerant.

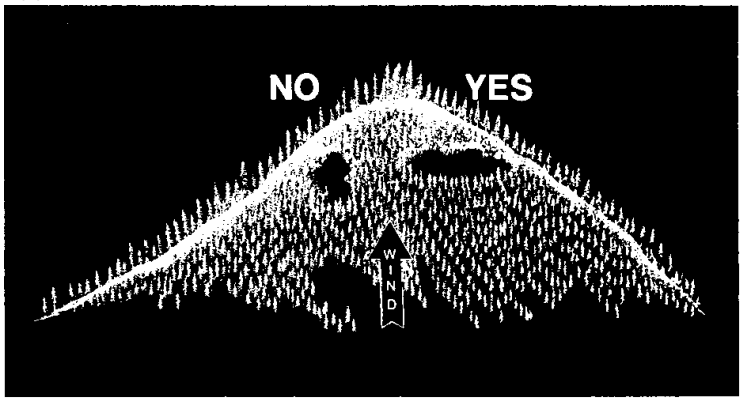
98

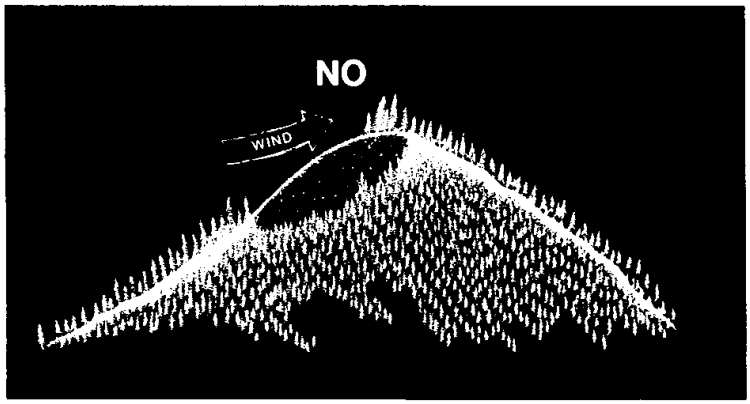
98. On the other hand, sun-adapted and more drought-resistant species are better adapted to these sites and regenerate them more quickly. These include the southwestern white pine, shown here, as well as blue spruce, aspen, and ponderosa pine.

99. But without fill-in planting, clearcuts on south slopes seldom produce acceptable stands of natural reproduction within a suitable period of time, regardless of the species.

99

100





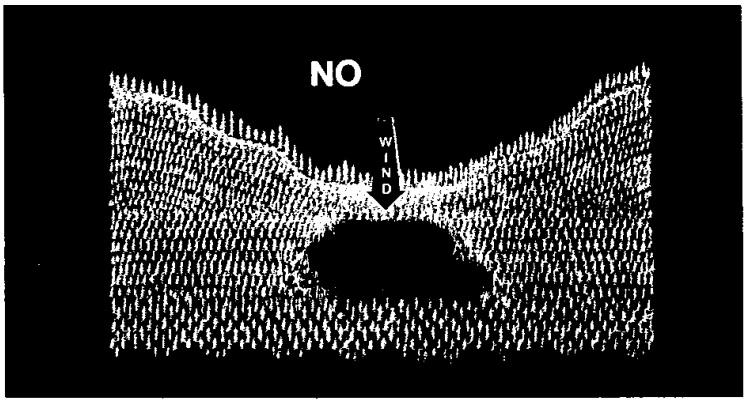
101

100. And keep in mind the wind patterns when you're laying out a clearcut (Alexander 1964, 1967, 1974). Avoid clearcuts that run upslope and are parallel to the wind direction, as shown on the left. Instead, lay them out across the slope, with the short dimension of the clearcut parallel to the wind, as on the right.

101. Also avoid laying out clearcuts on ridge tops,. . .

102. . . .or directly below saddles where wind vortexing increases blowdown risk.

103. Use irregular cutting boundaries without sharp indentations or square corners to reduce blowdown.



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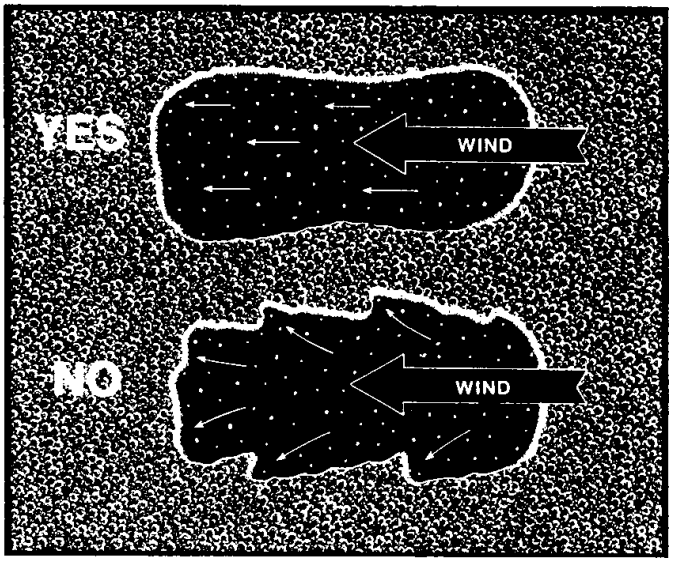


103

104

104. Don't locate clearcut boundaries along poorly drained or shallow soils like this. Instead, place them in stands of sound trees or in immature or poorly stocked stands, which naturally are more windfirm.

So far, our clearcutting guidelines have been for conifers.

ASPEN

105

105. But you can also clearcut aspen. In fact, clearcutting is the best treatment if you want to maintain aspen (Shepperd and Engelby 1983). Aspen is sometimes clearcut . . .

106

106. . . . to produce sprouts for deer and elk food. Where big game and livestock populations are high, cut large acreages to help reduce the impact of browsing damage (Patton and Jones 1977).

PARTIAL CUTTING

107

108

109

107. Now, let's look at **partial** cutting techniques to regenerate mixed conifer stands. These cuts minimize windthrow or logging damage to the residual stands, and they provide a seed source and a suitable environment for new stands of preferred species.

108. The following guidelines on partial cutting assume you're dealing with stands that consist mainly of species that are vulnerable to wind damage, such as Engelmann spruce and true firs.

109. In reality, these guidelines will vary because of the presence of windfirm pines and Douglas-fir, and the moderately windfirm blue spruce and aspen. We'll cover the variations later in the section on cutting modifications.

110

PARTIAL CUTTING

1. With Advance Regeneration

111

112

113

110. Let's now review some general guidelines for partial cutting where there's advanced regeneration.

111. Here you could remove the overstory in one step if there's low wind risk to the residual stand, and if the volume to be removed is light enough to keep damage to a minimum during logging or slash disposal. But most cases call for a partial cut.

112. Remember, to achieve satisfactory restocking with advanced regeneration, manage for those species that already exist.

Depending on the openness of the stand during establishment, these may include the more tolerant firs and spruces; but intermediate or intolerant species may also be present.

113. Assuming that the composition of existing regeneration is acceptable, you should evaluate its potential for future management by considering variations in age, quality, and quantity.

You must take different courses of action, depending on whether you decide to manage advanced reproduction or not. For example, regeneration severely damaged by the western spruce budworm or by dwarf mistletoe may have to be eliminated.

114

115

116

Uniform Spacing	→	Use Shelterwood Cut
Irregular Spacing	→	Use Group Selection

117

114. Also, to tell whether or not the stand needs supplemental stocking, reevaluate the stand **after** the final harvest and slash disposal.

Careless logging and slash disposal can virtually destroy the residual stand and can negate your prescription.

115. When you use advanced regeneration, the size, shape, and arrangement of openings are not critical from a **regeneration** standpoint. But they must be compatible with other key uses.

For instance, if water yield is a key consideration, then the best size of openings is about three to eight times tree height (Rich and Thompson 1974). Where scenic values are important, openings should be irregular in shape and blend into the landscape.

116. In general, use a shelterwood cut where trees are uniformly spaced, and a group selection where they are clumpy. Regardless of stand structure, you may need to remove the overstory in more than one step.

Remember, the amount of basal area that can be removed at each entry, the number of entries, and the size of group openings is determined by stand characteristics and windfall risk (Shepperd and Alexander 1983b).

117. In multiple-use areas, such as this campground, where you want to minimize changes in forest cover, use individual tree selection. But this favors more tolerant species.

STANDS WITHOUT ADVANCED REGENERATION

118

PARTIAL CUTTING

1. With Advance Regeneration

2. Without Advance Regeneration

118. In the second case, in stands with **no** advanced regeneration, use shelterwood or selection methods to provide an effective seed source. Leave either an overstory canopy, or trees standing around the edges of small openings. These trees also provide a good environment for developing seedlings. But always prepare...

119

119. ...a suitable seedbed after the seed cut where you use shelterwood cutting, and after each cut where you use a group selection or an individual tree selection.

Before we discuss the guidelines for partial cutting in specific types of stands...

120

Let's Review...

120. ...let's take another discussion break.

SUMMARY

Regeneration Silviculture of mixed conifer stands depends on the existing species composition and on the potential indicated by the habitat type. In addition, you must consider management objectives, stand conditions, tolerance, windfirmness, environmental factors, regeneration problems, and susceptibility to insects and diseases.

Cutting Guidelines should be based on management objectives and on individual stand characteristics. You can use clearcutting, shelterwood, and selection cutting and their modifications. Restocking can rely on advanced regeneration or on natural or artificial regeneration.

Clearcutting favors shade intolerant species. Use these guidelines to clearcut conifers:

- Specify layout, slash disposal, and seedbed treatments to facilitate seed dispersal and create good conditions for germination, establishment, and survival.
- Vary clearcut opening sizes to ensure that all parts of the cut are within seed dispersal range of the desired species.
- Consider wind patterns when laying out clearcuts.

Clearcutting is the best way to maintain aspen. Cut large acreages to help reduce browse damage in areas with high populations of big game or livestock.

Partial cutting minimizes windthrow and logging damage to the residual stands, and provides a seed source and an environment for regeneration. In stands with advanced regeneration susceptible to wind damage:

- Manage for those species that already exist.
- Evaluate the future potential of existing regeneration.
- Reevaluate the need for supplemental stocking after the final harvest and slash disposal.
- Use a shelterwood where trees are uniformly spaced.
- Use a group selection where trees are in groups.

In stands without advanced regeneration:

- Leave either an overstory canopy, or trees standing around the margins of small openings.
- Provide a suitable seedbed (a) after the seedcut when shelterwood cutting, and (b) after each cut when using a group selection or individual tree selection.

121. Again, discuss these questions to review the material you've just seen.

(For guidelines for discussing questions no. 121a, 121b, and 121c, refer to pg. 68.)

121a. From a silvicultural standpoint, why are the shape and size of clearcuts important to consider when developing the management prescription? What factors influence the size, layout, and shape of clearcuts which you prescribe?

121b. What factors should be considered when planning a harvest designed to regenerate aspen? What are the main differences between a prescription for an aspen clearcut and a conifer clearcut? Explain.

121c. What structural characteristics of a stand influence the selection of shelterwood cutting? Why? What factors influence the use of group selection?

121d. Think of three different mixed conifer stands on different sites within your District or Forest. Considering stand characteristics and overall management objectives, will you be able to cultivate existing advanced reproduction, or will you have to rely on natural or artificial regeneration? If the advanced regeneration were satisfactory but consisted of tolerant species, would you still cultivate it, or would you try to establish more intolerant species?

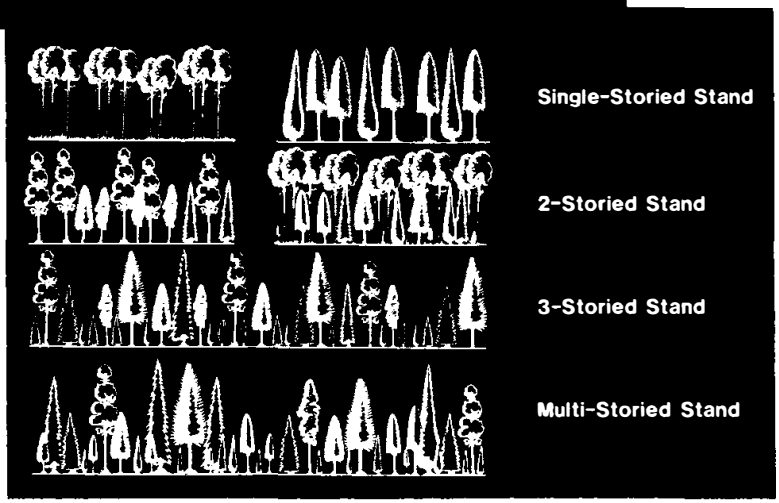
121e. Given your local conditions, the Forest's management objectives, and site conditions, which specific items of the regeneration triangle will infuence your prescriptions for clearcutting the most? Which specific items of the regeneration triangle will influence your prescriptions for partial cutting the most?

122

PARTIAL CUT AREAS

Regeneration by New Reproduction

- Composition
- Habitat Type
- Structure
- Distribution
- Wind Risk
- Stocking level



123

122. Our review of regeneration silviculture has prepared us for discussing partial cutting in different types of stands. Again, we're dealing with a mixture of as many as eight species, each with its own regeneration needs. Once you've decided which species to favor, you must determine the best silvicultural system, cutting methods, and schedule for cuts. To do this, you must consider these six key factors. Depending on the species in the stand, one factor may be more important than another.

123. We'll now outline cutting guidelines based on **stand structure** (Alexander 1973). First we'll discuss single-storied stands, then two-, three-, and multi-storied stands. Remember, much of the discussion is based on the assumption that the stands consist of easily windthrown species.

SINGLE-STORIED STANDS

124

A. Single-Storied Stands

1. Aspen Overstory
2. Spruce-Fir Overstory

125

124. You may occasionally run into single-storied inclusions of aspen or Engelmann spruce-corkbark fir within larger mixed conifer stands. Since they're pure stands of a single species, treat them as such. When aspen predominates, stands are usually clearcut. When spruce and fir predominate, consider wind risk first in your prescriptions. For more detailed cutting guidelines,. . .

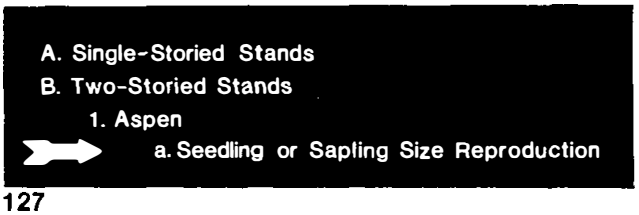
125. . . .refer to the companion slide tapes in this series. They cover each of these pure stands in more detail.

TWO-STORIED STANDS

126

126. Now, consider two-storied stands. Their overstories can be aspen, ponderosa pine, or other conifers. In many two-storied and in multi-storied stands, you may be able to achieve satisfactory restocking by cultivating existing advanced regeneration, providing it meets management needs.

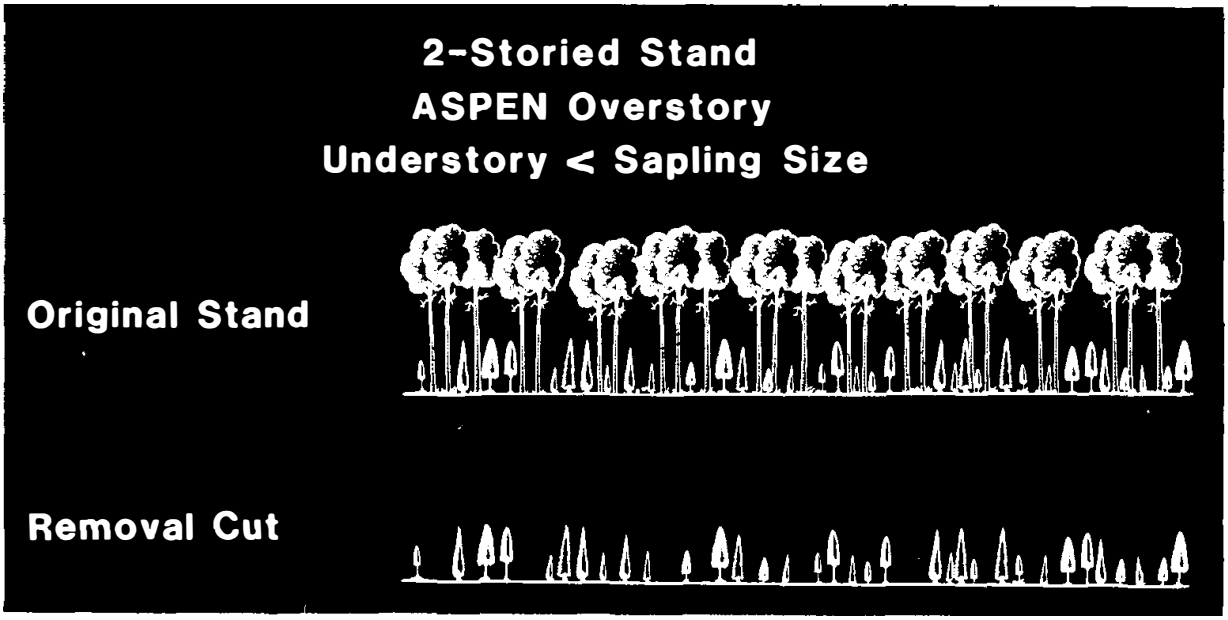
Aspen Overstories



127

127. In two-storied aspen stands, the understory is usually mixed conifers. If the understory is seedlings or small saplings, and you want to manage for conifers,. . .

128. . . .remove the overstory in a single cut to release the conifers. Aspen suckers will fill in the gaps.



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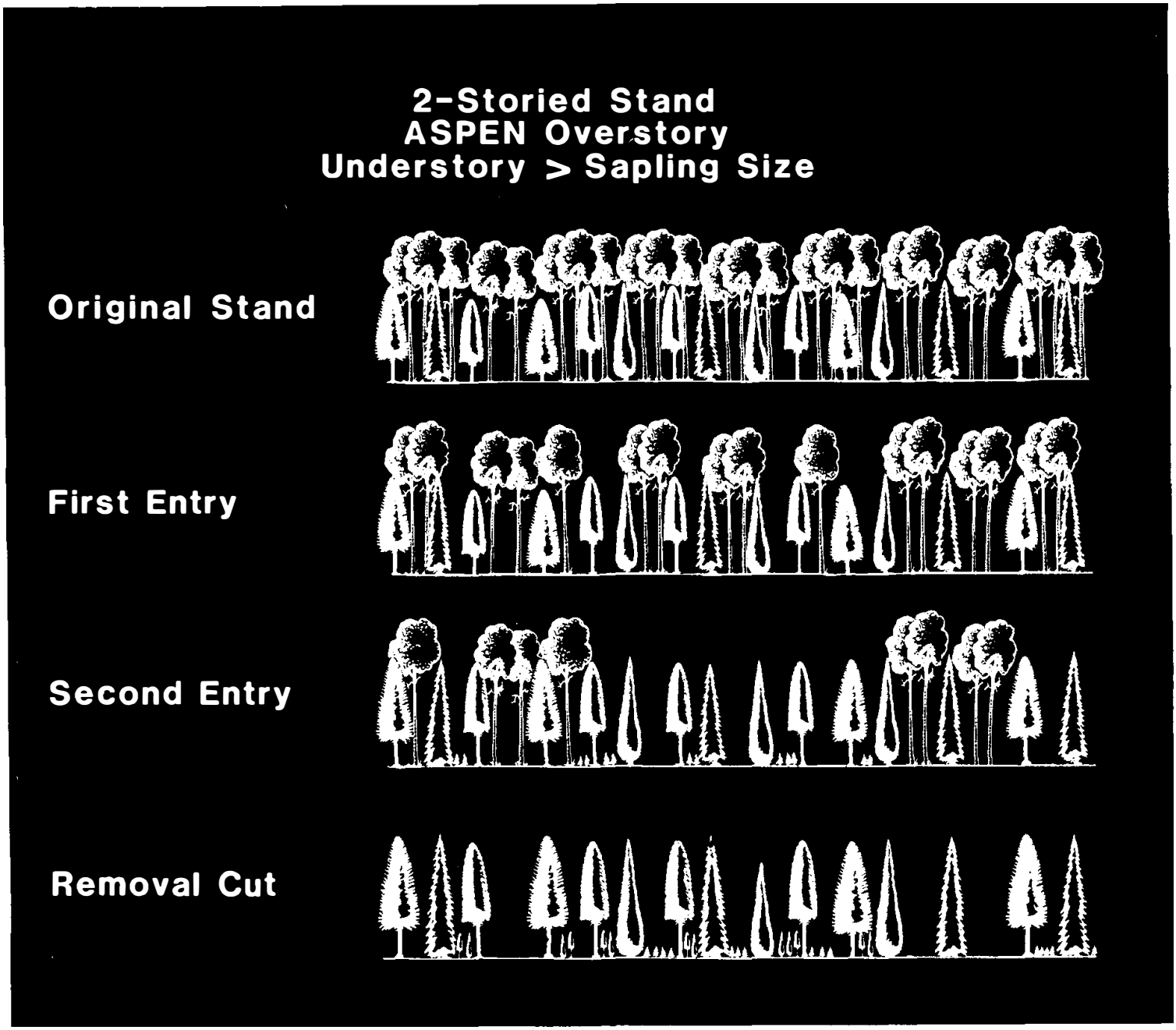


129. If the understory consists of trees larger than saplings, it is more susceptible to windthrow (Jones 1974). Again, if you want to manage for **conifers,** the aspen overstory should be removed in two or three cuts. Be especially careful to avoid logging damage to the residual aspen because of its susceptability to disease. But remember, if you want to maintain the **aspen,** you must clearcut.

Ponderosa Pine Overstories

A. Single-Storied Stands
B. Two-Storied Stands
1. Aspen
a. Seedling or Sapling Size Reproduction
b. Reproduction Larger than Saplings
➔ 2. Ponderosa Pine

130

130. The second type of two-storied stands have overstories of ponderosa pine (Jones 1974). The understory usually consists of the more tolerant species. You must decide if you want to manage for the existing understory or if you want to encourage the more intolerant species.

Ponderosa Pine Overstory
CRITICAL FACTORS

- Windrisk
- Stand Conditions
  - (a) Understory size class
  - (b) Stocking level
  - (c) Species composition
  - (d) Density of overstory
- Management objectives (desirability of species)

131

131. To determine the best cutting methods to use, you must consider these three key factors.

BELOW AVERAGE WINDFALL RISK . . .

132

A. Single-Storied Stands
B. Two-Storied Stands
1. Aspen
a. Seedling or Sapling Size Reproduction
b. Reproduction Larger than Saplings
2. Ponderosa Pine
a. Below Average Wind Risk
➔ (1) Well-stocked Understory

Well-Stocked Understory

132. In cases where windfall risk is low and stands have a well-stocked understory, you have three options.

2-Storied Stand
PONDEROSA Overstory
Well-Socked Understory
Below Average Windfall Risk

Option I:
Residual Protection Not Needed

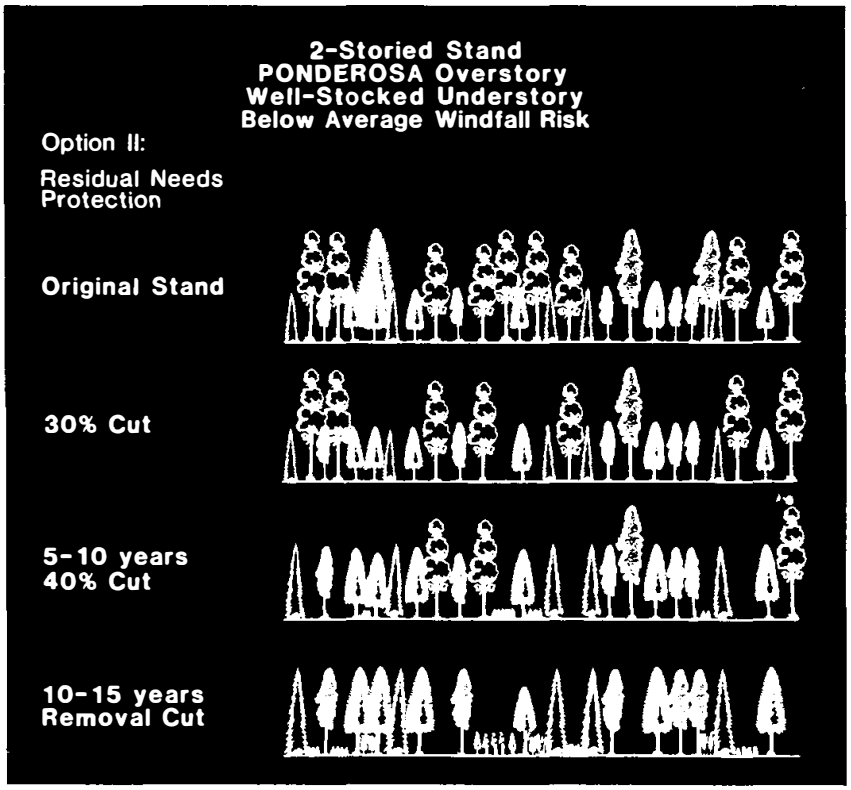
Original Stand

Removal Cut

133

133. Where the understory consists of seedlings and saplings and there's little risk of logging damage, then you can remove the overstory in a single, carefully planned and controlled cut.

134

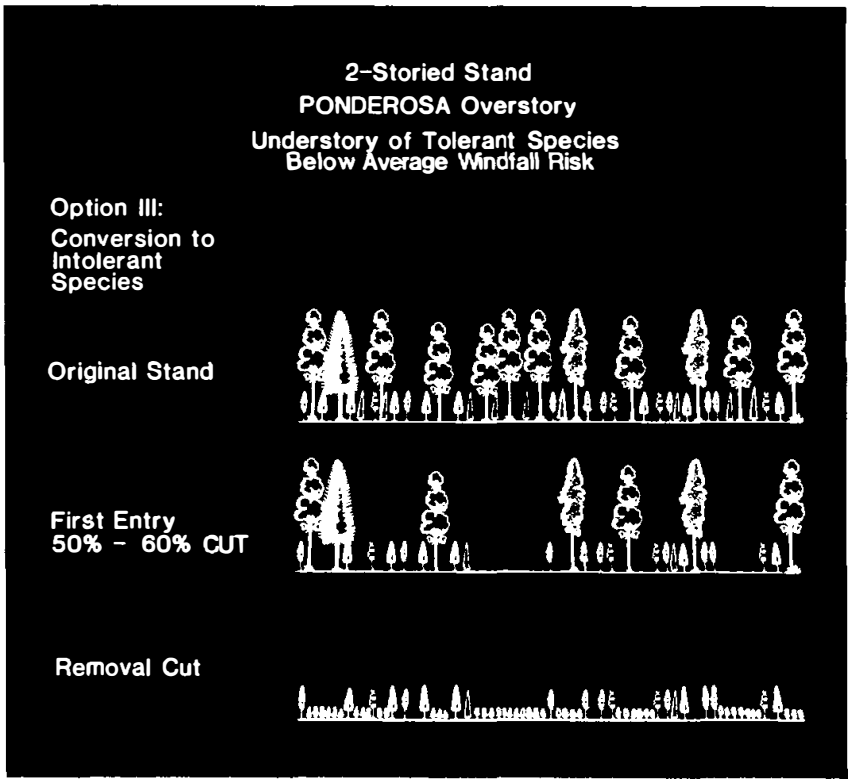


134. The cutting procedure shown in Option II is used to reduce logging damage to the residual stand and to protect a pole-sized understory from blowdown.

Remove the overstory in a series of cuts. The first cut should take about 30% of the basal area. Mark trees for removal on an individual basis. Take the rest of the overstory in two to four more entries at 5 to 10 year intervals. In this example, the last two cuts are spread over a 15 to 25 year period.

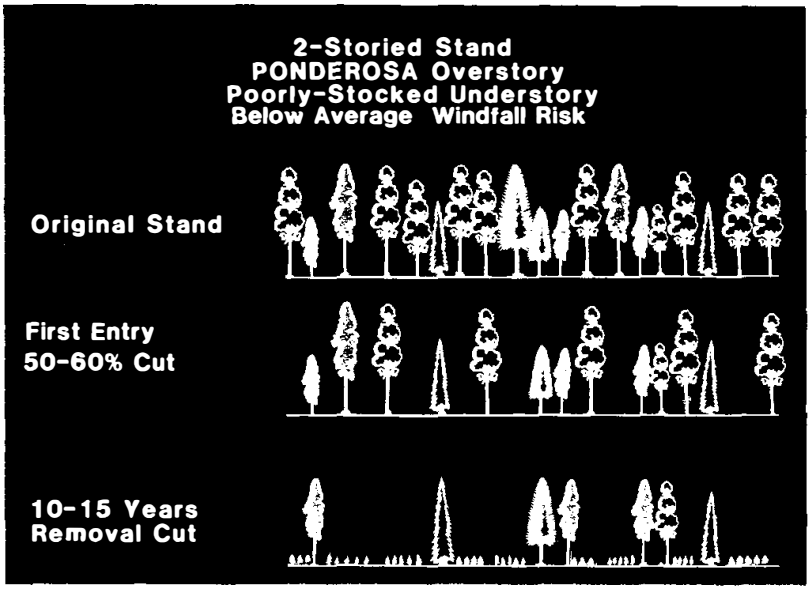
135. Use this third option where you want to convert the understory from tolerant to intolerant species.

The first cut should be heavy enough to open up the stand to encourage regeneration of intolerant species. To do this, cut 50% to 60% of the basal area spread over both stories; then prepare a suitable seedbed. Make the removal cut in about 10 to 15 years.



135

136



Poorly Stocked Understory

136. Use a similar prescription for stands with poorly stocked understories.

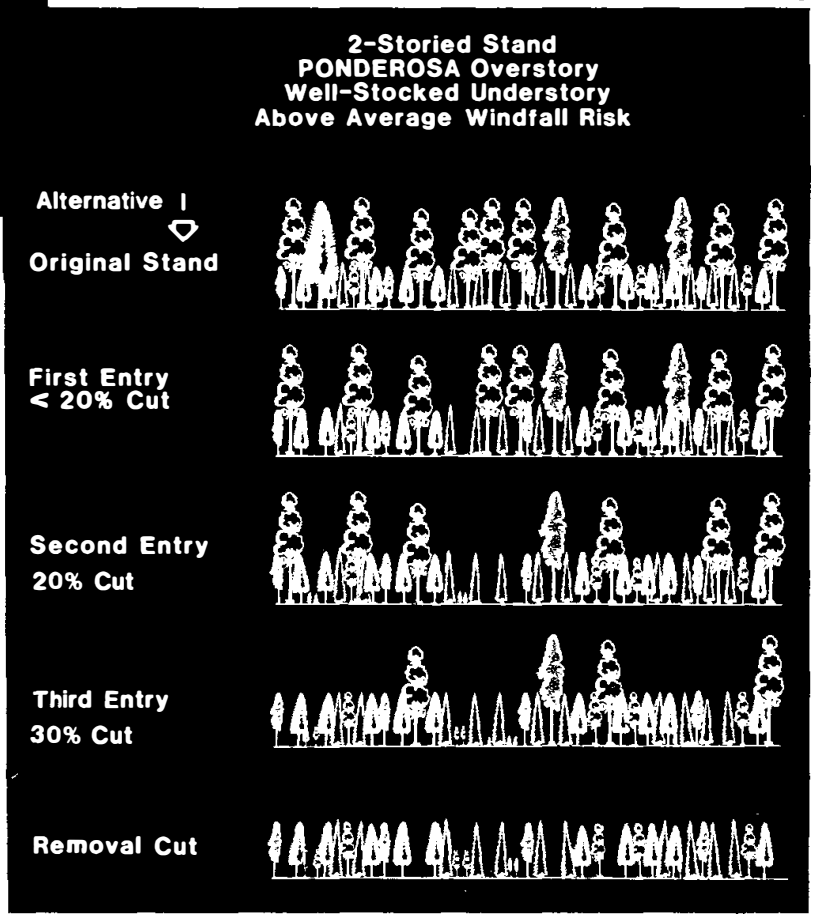
137

A. Single-Storied Stands
B. Two-Storied Stands
  1. Aspen
    a. Seedling or Sapling Size Reproduction
    b. Reproduction Larger than Saplings
  2. Ponderosa Pine
    a. Below Average Wind Risk
      (1) Well-stocked Understory
      (2) Poorly stocked Understory
    ➔ b. Above Average Wind Risk

ABOVE AVERAGE WINDFALL RISK

137. If the windfall risk is above average...

138



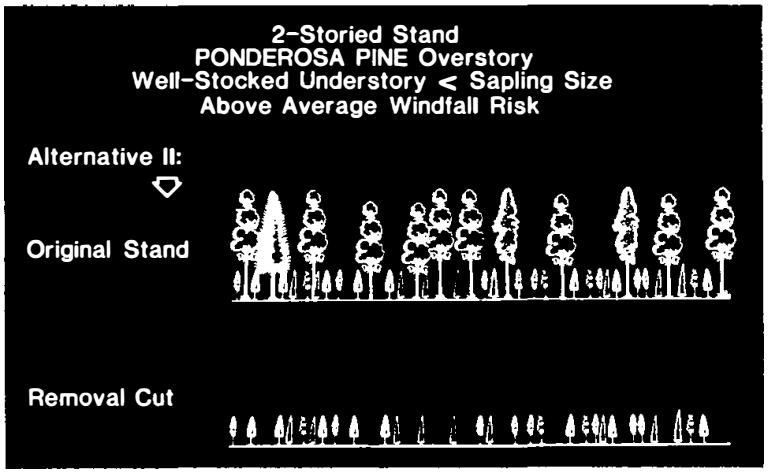
138....you should harvest stands in a series of light cuts at 10-year intervals. This protects remaining trees from windthrow.

Do not exceed 20% in the initial cut. With four entries, the first two cuts should each remove 20% of the basal area, and the last two, 30% each.

This kind of cut, shown here to manage advanced regeneration, can be used...

139

- Well-stocked with Desirable Species
- Well-stocked with Undesirable Species
- Poorly stocked or Non-stocked Understory

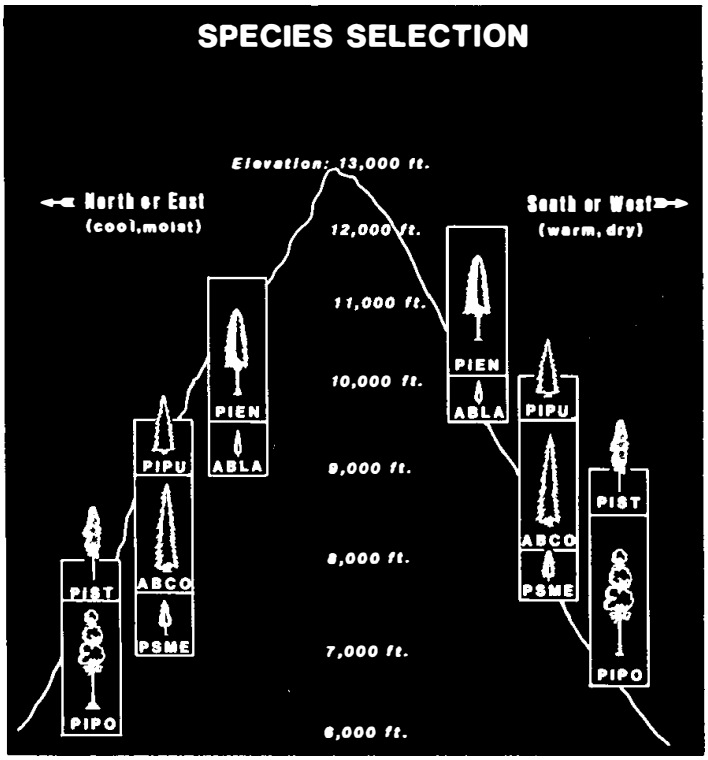


140

139. . . . under several stand conditions. Use it to establish regeneration or maintain or alter existing understories. To help accomplish these goals, you may have to remove a portion of the understory. You have a second alternative with moderate windrisk when the . . .

140. . . . understory is well stocked with seedlings and saplings, and logging damage to the residual is not a problem. Here you can remove the overstory in a single cut.

141



141. Remember the relationship between species and site. In poorly stocked stands, you'll usually want to regenerate ponderosa pine. But you should favor other species on moister sites or at higher elevations.

Overstories of Other Conifers

142

143

142. The third type of two-stored stands has overstories mainly of conifers **other than** ponderosa pine (Jones 1974). The second story often consists of trees greater than 4 inches in diameter and is sometimes poorly stocked and clumpy. Here, wind risk becomes an important factor, because the smaller trees are vulnerable to blowdown.

143. As before, consider windfirmness, environmental factors, dwarf mistletoe, and density of the overstory canopy to determine which species to manage.

BELOW AVERAGE WINDFALL RISK . . .

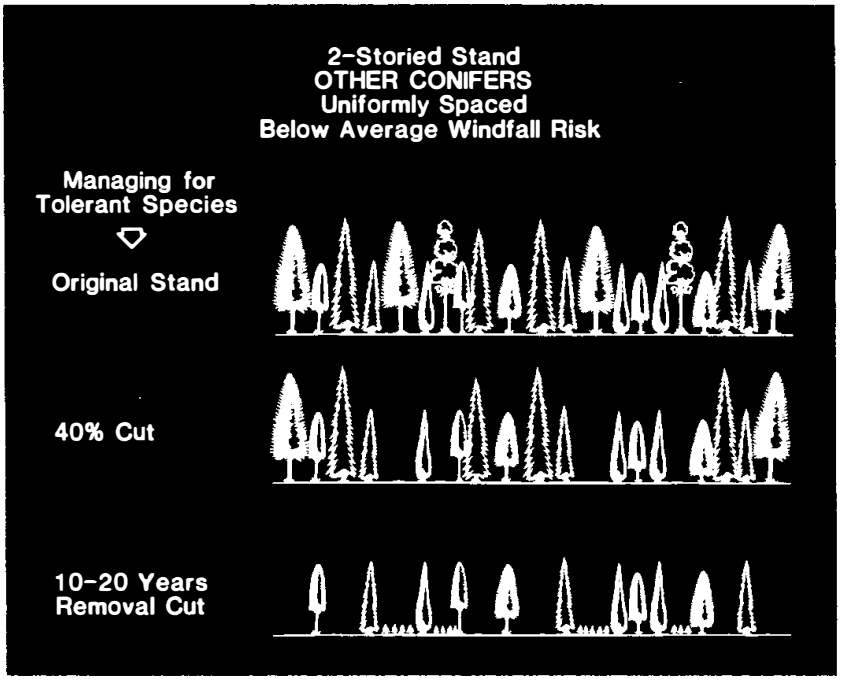
144

A. Single-Storied Stands
B. Two-Storied Stands
  1. Aspen
    a. Seedling or Sapling Size Reproduction
    b. Reproduction Larger than Saplings
  2. Ponderosa Pine
    a. Below Average Wind Risk
      (1) Well-stocked Understory
      (2) Poorly stocked Understory
    b. Above Average Wind Risk
  3. Other Conifers
    a. Below Average Wind Risk
      ➔ (1) Uniformly Spaced

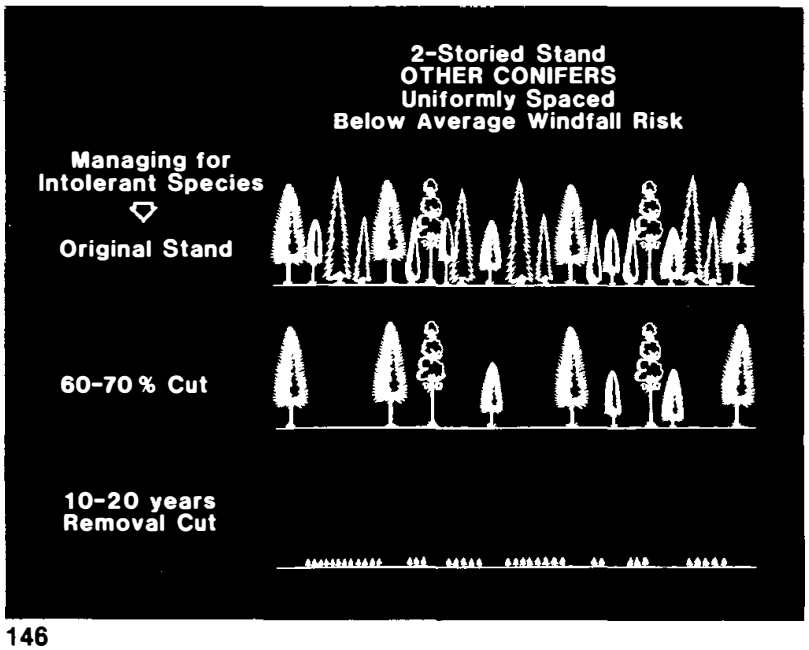
Trees Are Uniformly Spaced

144. In stands where trees are **uniformly spaced** and wind risk is below average,. . .

145



145. . . . and where you're managing for **tolerant** species, take up to 40% of the basal area in the first cut, following up later with a removal cut.



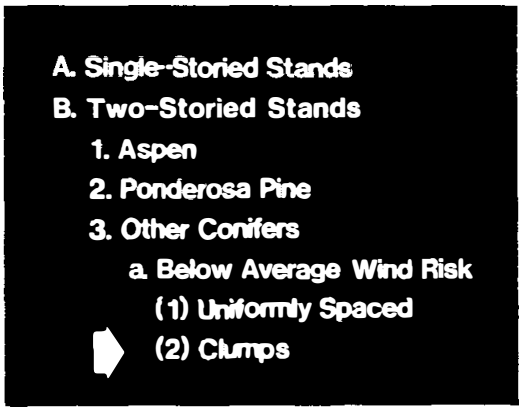
146

146. Where you're managing for **intolerant** species, take up to 60% to 70% in the first entry, depending on windfirmness of the stand.

This higher cut resembles the seed cut, or first step, in a two-cut shelterwood, but you should mark so that mature trees are removed from each story. For seed trees, leave selected dominants and codominants that are vigorous and free of defects. Again, don't cut holes in the canopy. Instead, leave dominants in the interior of the stand that protect trees to the leeward that will be harvested in the next cut.

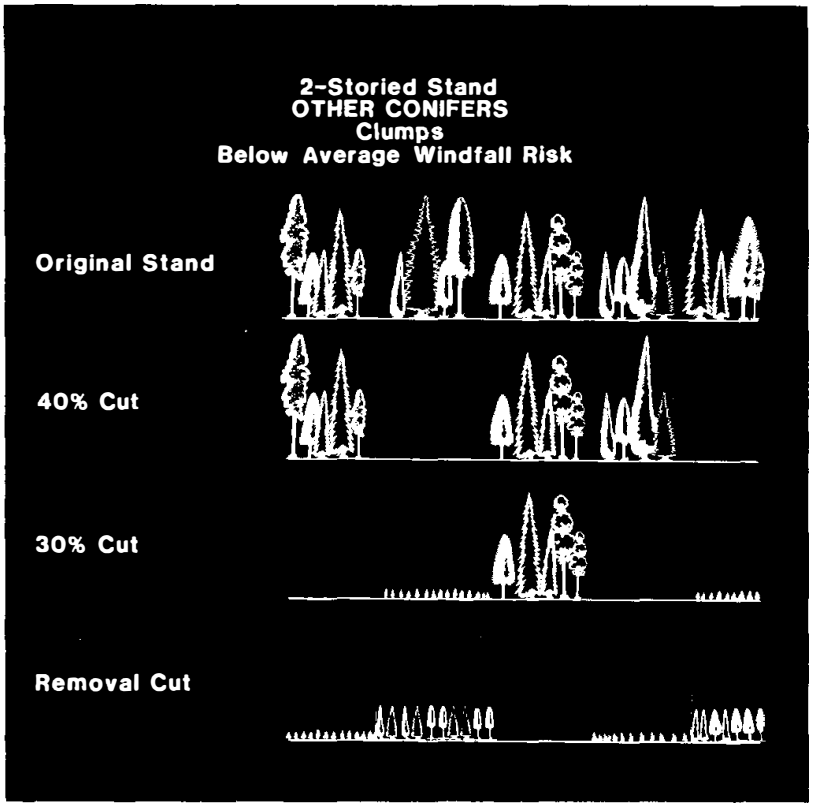
Trees in Groups

147



147. In the more common situation where stands are clumpy, remove . . .

148 · 149



148. . . . about 40% of the basal area in the first cut (Shepperd and Alexander 1983b). This simulates a group selection. Generally, either leave or cut all trees in a group. And leave windfirm species or size classes along the boundaries. Group openings should have irregular shapes and can be up to three tree heights in diameter.

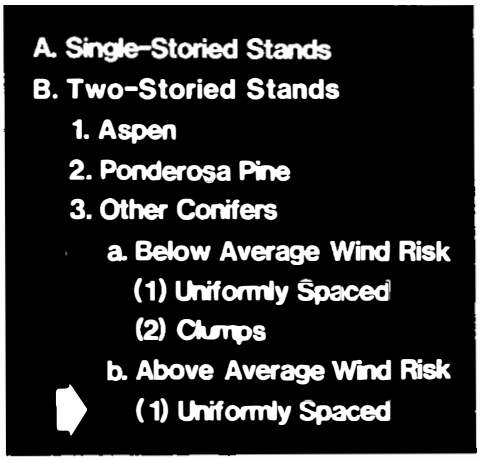
This method favors intermediate and intolerant species, if they're present in the residual stand as a seed source. Or if such trees are cut and the **tolerant** *trees are left as a seed source, the opening would probably regenerate to tolerant species (Ronco et al 1983).*

149. Take the rest of the overstory in two additional cuts similar to the one just described. Enlarge group openings or cut new openings.

ABOVE AVERAGE WINDFALL RISK . . .

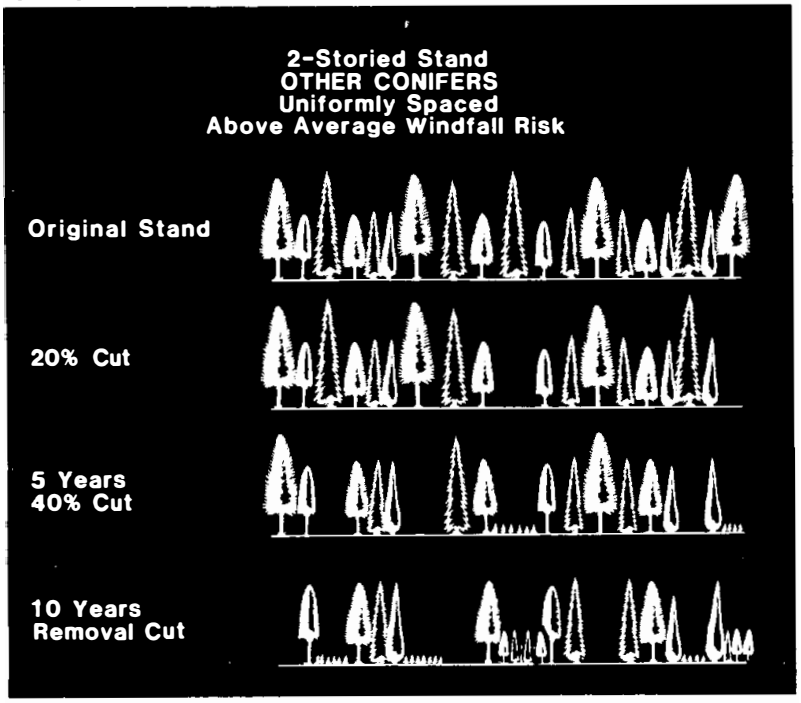
Trees Are Uniformly Spaced

150



150. In two-storied stands of other conifers, where the wind risk is **above** average and trees are uniformly spaced,. . .

151·153



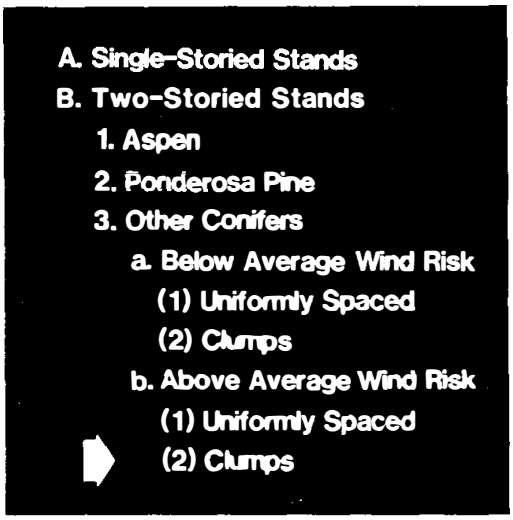
151. . . .use a light cut that removes 20% of the basal area on an individual tree basis. In this first cut, remove predominants, intermediates with long dense crowns, and trees with known indicators of defect. But maintain the general level of the canopy (Jones 1974, Shepperd and Alexander 1983b).

152. Use this cut to open up the stand to minimize windfall like this. And salvage any windfalls.

152

153. Schedule at least two more cuts at 5- to 10-year intervals to remove the rest of the overstory.

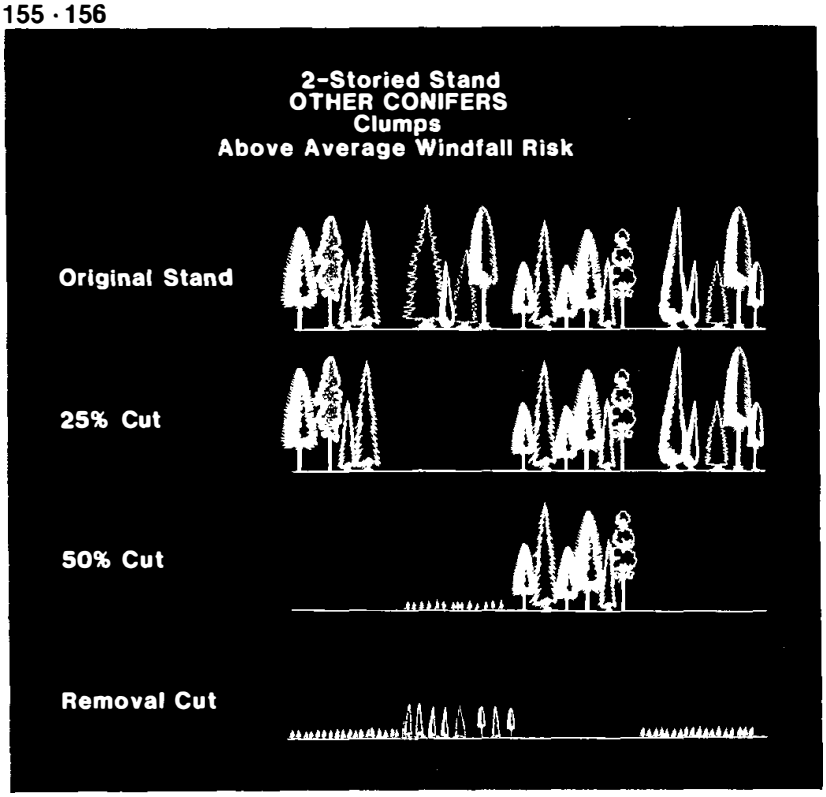
154



Trees in Groups

154. For above-average windfall risk and **clumpy** trees, . . .

155 · 156



155. . . . first take about 25% of the overstory basal area, using a group selection cut (Shepperd and Alexander 1983b). Either cut or leave all trees in a group. Keep openings smaller than those in lower wind risk areas, and less than two tree heights in diameter.

Enlarge small, natural openings by removing groups to the windward of the opening, thus preserving windfirm trees on the leeward side.

156. Take the rest of the overstory in two more cuts, but retain the favored species as a seed source until the final removal cut.

VERY HIGH WINDFALL RISK

157

A. Single-Storied Stands
B. Two-Storied Stands
1. Aspen
2. Ponderosa Pine
3. Other Conifers
a. Below Average Wind Risk
(1) Uniformly Spaced
(2) Clumps
b. Above Average Wind Risk
(1) Uniformly Spaced
(2) Clumps
c. Very High Wind Risk

157. For high windfall risk, either remove **all** the trees, or leave the area **uncut.**

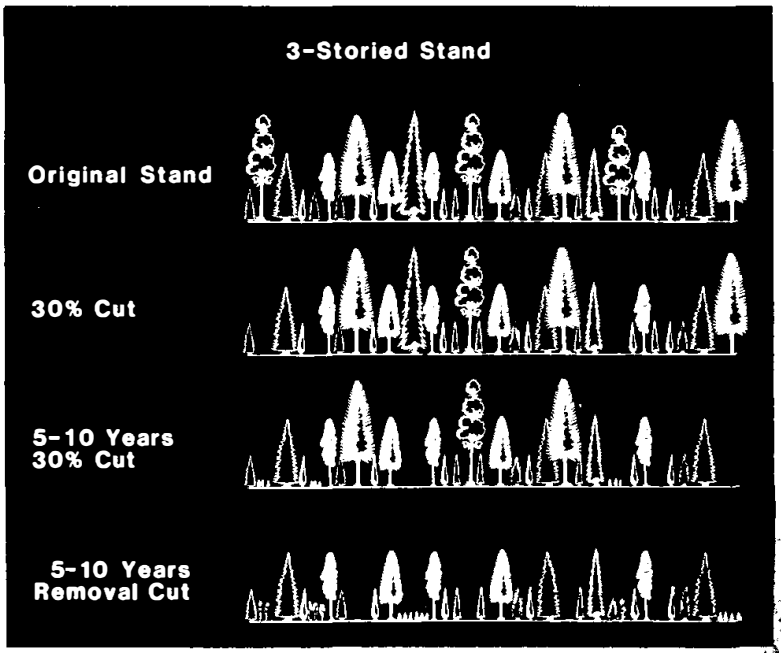
Cleared openings should meet regeneration needs of the species, and should be interspersed with uncut areas. In any case, don't cut more than ⅓ of the area in any one entry.

THREE-STORIED STANDS

158

A. Single-Storied Stands
B. Two-Storied Stands
C. Three-Storied Stands

158. Now, let's consider three-storied stands (Jones 1974). Here the **overstory** is usually reasonably windfirm, except where it occurs in large groups. But the **second** story may be quite susceptible to windfall. If you remove the overstory entirely, the second story could suffer serious blowdown.



159

159. To **prevent** serious blowdown, remove the overstory in two or three cuts

over a 10- to 20-year period. At the same time, you can do light TSI cuts in the lower stories.

160. If spacing in the resulting stand is uniform, then the residual stand will be stocked. So you won't need a reproduction cut until the overstory matures. If the stand is clumpy, use treatments similar to those for two-storied stands.

Dwarf mistletoe infestations may later require some sanitation cutting.

160

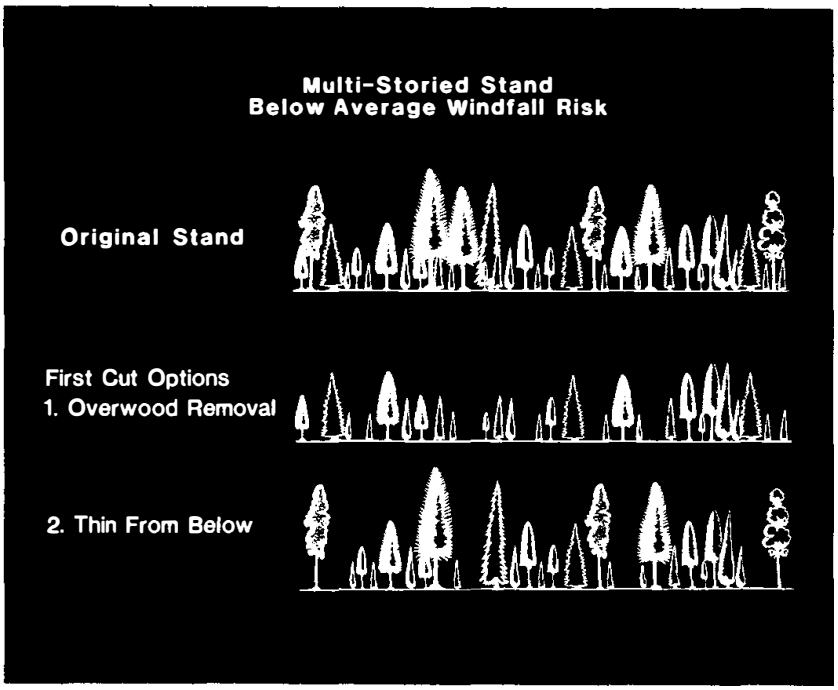
MULTI-STORIED STANDS
Below Average Windfall Risk

161

A. Single-Storied Stands
B. Two-Storied Stands
C. Three-Storied Stands
D. Multi-storied Stands
➧ 1. Below Average Wind Risk

161. Finally, let's consider multi-storied stands, which are usually the most windfirm (Jones 1974, Shepperd and Alexander 1983b). When wind risk is below average...

162 · 163



162. ...you have lots of flexibility in harvesting them. You can cut all age classes. For instance, your first cut could remove the overstory to release the younger age classes,...

If you make an overwood removal in stands where the volume is too heavy, harvest it in two cuts to avoid excessive damage to the understory. And then, direct your cutting toward either even- or uneven-aged management.

163. ...or else you could thin from below to improve the spacing of the larger trees.

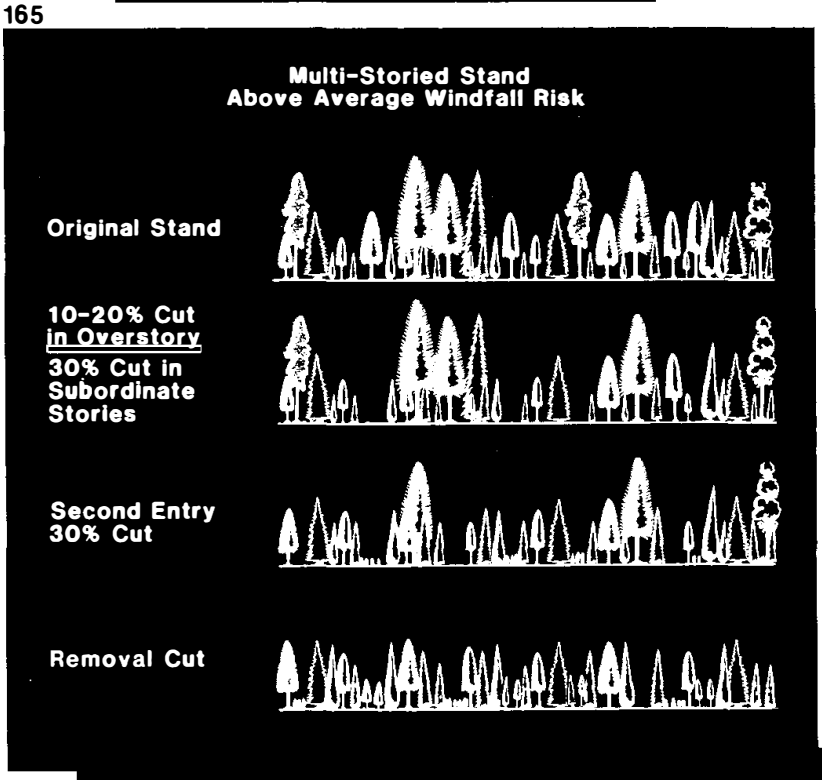
Above Average to Very High Windfall Risk

164

A. Single-Storied Stands
B. Two-Storied Stands
C. Three-Storied Stands
D. Multi-storied Stands
1. Below Average Wind Risk
➧ 2. Above Average or Very High Wind Risk

164. When wind risk is above average to very high, the safest first cut should . . .

165

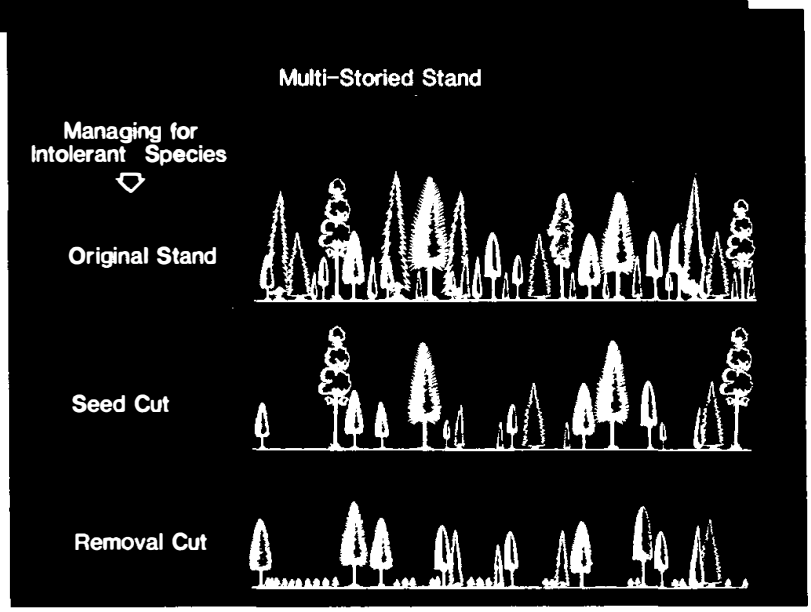


165. . . . remove 10% to 20% of the overstory. But at the same time, you can take up to 30% of the basal area of subordinate stories. Later direct cuts to either even- or uneven-aged management.

The examples we just showed for three-storied and multi-storied stands explained how to manage for advanced regeneration of tolerant species.

166. But you can also elect to favor intolerant species by further opening up the stand. Do this by removing intermediate and codominant trees that are the most susceptible to windthrow.

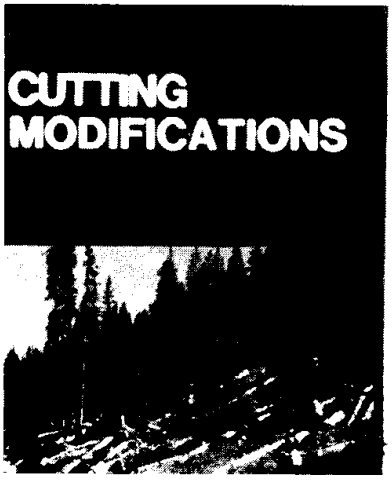
This results in a seed cut that should leave about 30% to 40% of the most windfirm overstory trees as a seed source. You may also need to open the stand from below to promote establishment of intolerant species.



166

CUTTING MODIFICATIONS

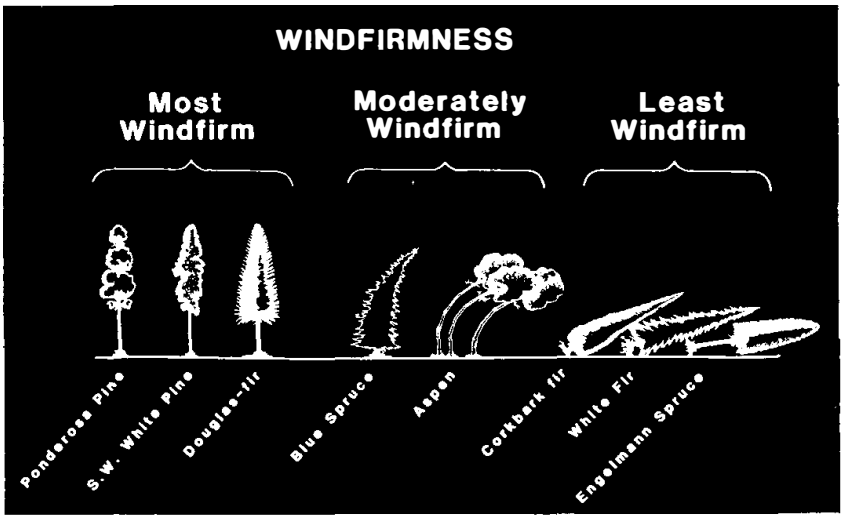
167



167. As you've seen, each stand has its own characteristics, and you must consider each one individually. Remember, we've just discussed some general guidelines. Management objectives and other factors may mean you must modify your cutting method.

WINDFIRMNESS

168



168. For example, you can vary, to a certain extent, the amount harvested under different stand and wind risk conditions. This is because of the different windthrow susceptibilities of the composite species.

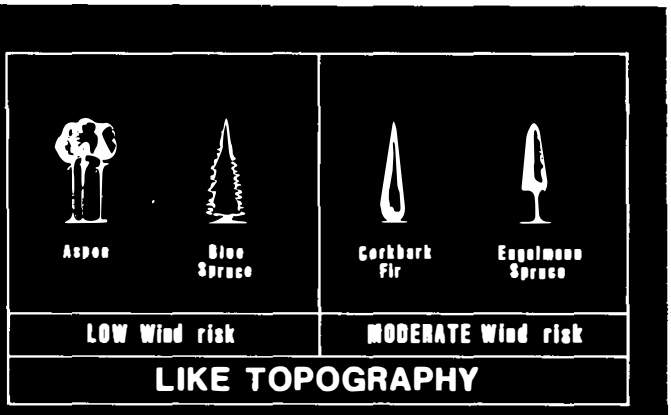
169. Where **only** pines or Douglas-firs are left after cutting, more trees than normally recommended can be cut except under extreme wind risk situations.

170. In other cases, the potential windfall risk will shift toward the next lower category where moderately windfirm species, such as aspen, will make up the residual stand. For example,. . .

169

170

171



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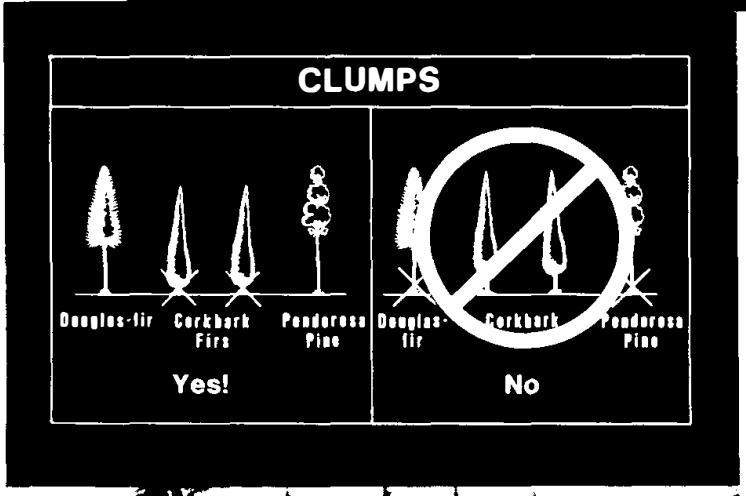
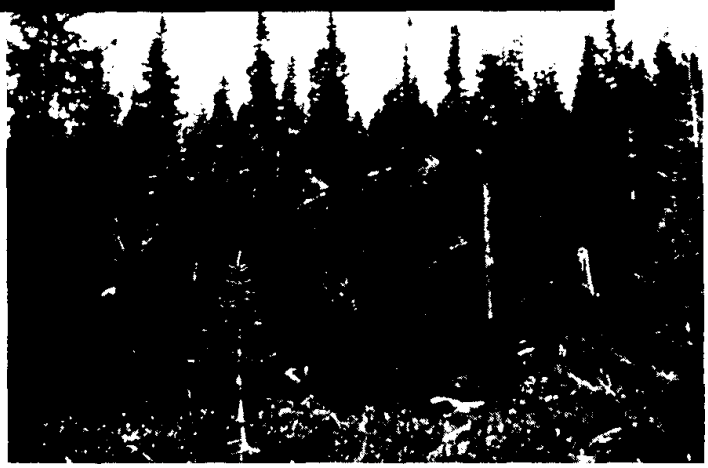




173

171. . . . under topographic conditions that are alike, the windrisk for spruce-fir stands may be moderate. But in stands with aspen and blue spruce on the same site, it would be low.

172. The inherent windfirmness of the species that are present will also allow you to alter cutting practices when you harvest groups. Remember, you must either cut or leave an entire group if **all** trees are susceptible to windthrow. But you could selectively cut a group if **windfirm** species are present. In the case shown here, cut susceptible corkbark fir and leave windfirm Douglas-fir and ponderosa pine.

173. But remember, when modifying cutting because of species ccmposition, you must consider the kinds of trees that would remain after cutting.

> *If the residual trees are firs and Engelmann spruce, and are more or less evenly distributed, then the stand must be treated as if it consisted entirely of susceptible trees, whether windfirm species are present or not.*

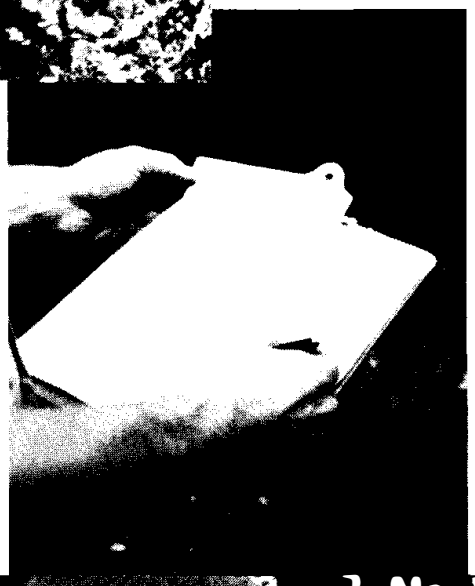
Stands are only as windfirm as their weakest species.

DWARF MISTLETOE

174

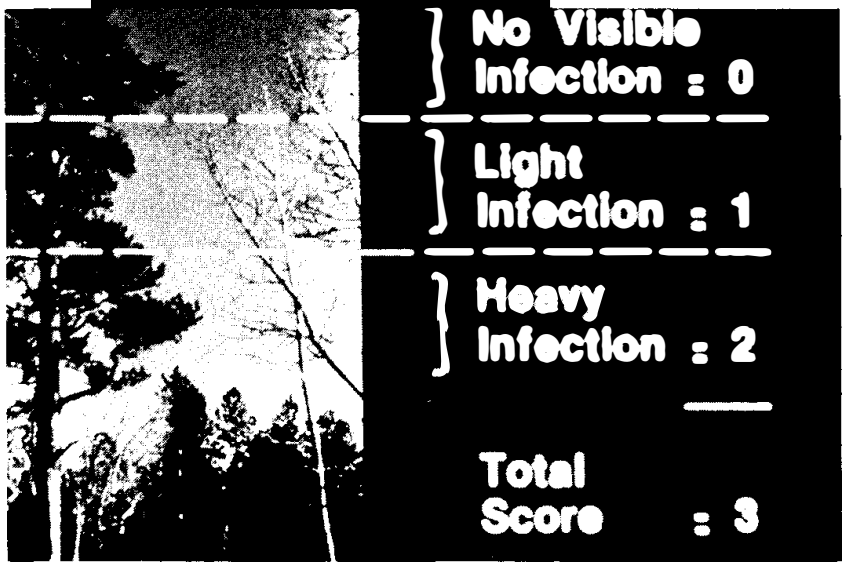
174. In another case, adjust cutting guidelines in dwarf mistletoe-infected stands. First,. . .

175



175. . . .inspect each stand carefully, and use the **six-class rating system** (Hawksworth 1977) to determine the severity of the infection. Under this system,. . .

176. . . .you can rate both individual trees, as well as entire stands, by determining the percentage of infected trees. But it's the stand rating for each species that determines the treatment.



176

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PARTIAL CUTTING IN MISTLETOE AREAS

* * * * * * * * * *

Rating < 2:

- Base your cut on stand and wind risk situation
- Cut infected trees when possible

Rating > 2:

- Cut all susceptible trees
- Accept consequences

177. Ideally, you should partially cut only those stands with a mistletoe rating of "two" or less. Remove as many infected trees as possible, but don't exceed the percentage of basal area recommended for the given stand characteristics and windfall situation.

178

178. In old-growth stands with an average rating greater than "two", any partial cutting intensifies the infection. So its safest to either. . .

179. . . .remove all the trees and start a new stand, or leave the stand uncut.

If you elect to make a partial cut anyway, your first cut should be heavy enough to be a regeneration cut. Then you will need to remove all infected trees left standing before the reproduction is 10 years old, or before it reaches three feet in height. Inspect regeneration periodically and make sanitation cuts as needed.

180. The alternative is to favor tree species that are not hosts for the most prevalent species of dwarf mistletoes (Gottfried and Embry 1977).

HOST RELATIONSHIPS of Dwarf Mistletoes

Main Host Tree → / Dwarf Mistletoe species ↓	Ponderosa Pine	S. W. White Pine	Douglas-fir	Blue Spruce	Engelmann Spruce	True Firs
Arceuthobium abietinum						•
A. apachecum		•				
A. blumeri		•				
A. douglasii			•			
A. microcarpum				•	•	
A. vaginatum	•					

180

In contrast to these detailed cutting modifications imposed by dwarf mistletoe, . . .

INSECTS

181. . . .our experience with insect-related modifications is limited. At this point we recommend you reduce the density of the prime host species by harvesting the overstory. You should also eliminate advanced regeneration if it's damaged beyond recovery. Also, encourage regeneration of non-host or less susceptible species (Ronco et al 1983).

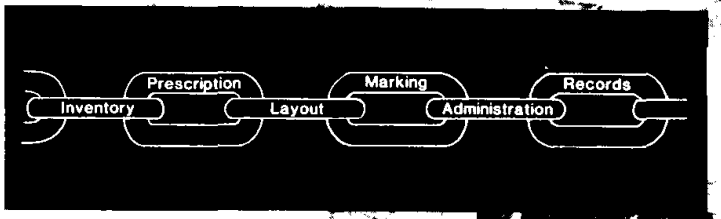
To minimize damage from ▽	. . . you should harvest ▽	. . . and favor ▽
Western Spruce Budworm	True Firs & Douglas-fir	Pines & Spruces
Western Tent Caterpillar	Aspen	Conifers

181

CONCLUSION

182

183



184

185

182. From what we've seen, mixed conifer forests in the Southwest are the most complex to manage, and yet they offer you a wider choice of options. You must consider many factors to develop proper silvicultural prescriptions to bring stands under management.

183. There are many operations that are crucial to successful silvicultural treatment. A breakdown or failure of any will result in the failure of the entire process.

184. You can't develop an accurate **prescription** without accurate **inventory** information. And the best prescription will do the stand no good if it's not applied properly.

185. Sale layout and marking personnel must fully understand the intentions of your prescription to apply it properly. Timber sale administrators must ensure that logging activities meet the requirements of the prescription.

Keep logging damage to a minimum, especially in stands with aspen and true firs, which are highly vulnerable to disease entering through trunk wounds.

186

187

186. Finally, keep accurate long term records to ensure that future activities within the stand are consistent with your original prescription and that they're properly scheduled.

187. Proper management requires every member of your team to work together.

188

188. This program is one of a series giving the state-of-the-art in silviculture of timber species in the Central and Southern Rocky Mountains. To obtain other slide programs in this series, or publications dealing with these subjects, contact the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

189

SUMMARY

When partial cutting mixed conifer stands, you must consider (1) composition, (2) habitat type, (3) structure, (4) distribution, (5) wind risk, and (6) stocking level for the species present.

Where single-storied stands of aspen or spruce-fir occur within larger mixed conifer stands, treat them as pure stands.

Two-storied stands can have overstories of aspen, ponderosa pine, or other conifers. Management objectives and windthrow, to some extent, are common considerations to all mixed conifer stands. But, other major factors to consider in determining your prescription differ for each kind of overstory.

In two-storied **aspen** stands, the **reproduction size class** is the important factor. It is usually of tolerant mixed conifers. First, decide whether you will manage for aspen or conifers. Then determine the size class of the understory reproduction and use appropriate cutting method.

In two-storied **ponderosa pine** stands, the major factors to consider are stand conditions (stocking level, **size of reproduction,** species composition and density of overstory). The understory also usually includes the more tolerant species. Determine the understory size class and whether the understory is well-stocked or poorly stocked. Weigh wind risk and use appropriate cutting method.

In two-storied stands with overstories predominantly of **conifers** other than ponderosa pine, **tree distribution** is an important factor. Determine whether the stand is clumpy or evenly spaced and whether the wind risk is high, moderate, or below average. Use proper cutting method.

Three-storied stands usually have a windfirm overstory, but an important point to remember is **wind risk** to the second story, which may be quite susceptible to blowdown. Use appropriate cutting methods to prevent serious windthrow.

Multi-storied stands usually are the most windfirm, but **wind risk** must still be considered. Before choosing an appropriate cutting method, determine whether the wind risk is below average, moderate, or very high.

Cutting Modifications may be necessary because of the degree of windfirmness, dwarf mistletoe, or insects. Use proper cutting methods to manage each stand individually.

The chain representing the silvicultural treatment of a stand has six links: inventory, prescription, layout, marking, administration, and records. With members of your management team working together to ensure no broken links, the silvicultural prescription that you develop for a mixed conifer stand will be successful.

190. Once again, discuss this final group of questions. Then, complete the programmed instruction questions at the end of your booklet.

(For guidelines for discussing questions no. 190a, 190c, and 190d, see pg. 70.)

190a. In the overall consideration of developing prescriptions for mixed conifer forests, what are the primary considerations that should guide you?

190b. When considering how the overall guidelines of this slide program apply to a particular stand in your area, what are the factors that you must take into account when developing a prescription? If the key factors are ignored, what will be the long-term impact on the forest?

190c. Consider the description that follows. Then, write a prescription for the stand, identifying the species for which you would manage. Explain your decision.

Stand description:

This mixed conifer stand is classified as an *Abies concolor/Quercus gambelii* habitat type (ABCO/QUGA HT).

Location: Capitan Mountains of New Mexico, 8,800 feet. It is a mesic site.

Topography: West-facing canyon slope, which is relatively steep.

Soils: Somewhat stony, but with good water-holding capacity.

Composition:

a. Sawtimber	24% white fir, 31% Douglas-fir, 16% southwestern white pine, 29% ponderosa pine.
b. Poles	34% white fir, 33% Douglas-fir, 14% southwestern white pine, 19% ponderosa pine.
c. Regeneration	45% white fir, 33% Douglas-fir, 14% southwestern white pine, 8% ponderosa pine.

Stand Data:

a. Sawtimber	Mature and overmature trees of all species, ranging from 120 to 140 years of age.
b. Poles	Small poles are sparse, while medium and large poles are more abundant and present in sufficient numbers to just constitute a manageable stand.
c. Regeneration	Seedlings and saplings fully stock the area.

Stand Structure: The stand is three-storied. resulting from the deterioration of the overstory in a virgin two-storied stand. The upper story is rather decadent. Trees are uniformly distributed over the area. The undergrowth has a 25% oak canopy cover, and occasional small openings have high coverage of New Mexico locust and Gambel oak.

Risk: Windrisk is average, with second-story trees susceptible to blowdown. Upper story trees show evidence of disease, but are relatively windfirm.

Management Objectives: Timber production.

190d. Consider the description that follows. Again, write a prescription for the stand, identifying the species for which you would manage. Explain your decision.

Stand Description: This mixed conifer stand is classified as *Abies concolor/Festuca arizonica* habitat type (ABCO/FEAR HT).

Location: White Mountains of Arizona, 7,900 feet, xeric site at lower elevational range of white fir and Douglas-fir.

Topography: West-facing canyon slope of moderate steepness.

Soils: Relatively deep profiles developed from sandstone parent material. The site is relatively dry.

Composition:

a. Sawtimber — 5% white fir, 22% Douglas-fir, 5% southwestern white pine, 68% ponderosa pine.

b. Poles and regeneration — nearly all white fir.

Stand Data:

a. Sawtimber — Pines and Douglas-fir are about 100 years old, whereas the white fir is about 85 years old.

b. Seedlings, saplings, and small poles are scattered throughout the stand, but are few in number. The stand is not adequately stocked with advanced reproduction in these size classes.

Structure: Although some regeneration is present, it does not occur in adequate numbers to form a distinct and manageable understory.

Risk: No unusual wind risk exists in the stand.

Management Objectives: Timber production.

190e. What new insights did the slide program provide you for developing prescriptions?

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HOW WELL DO YOU REMEMBER?

Read Directions Before Beginning

To complete this section, answer only one question on each page at a time..

Directions: (1) read question #1, (2) fill in the answer, (3) turn the page, (4) check the correct answer to question #1 in the left-hand column, (5) read and answer question #2, (6) turn the page, (7) check the correct answer to question #2 in the left-hand column, (8) read and answer question #3, (9) turn back to this page for the correct answer, (10) continue until you've finished all 17 questions.

	1. Mixed conifer forests can include up to _____ species.
(3) d	4. Critical needs for regeneration include _____, _____, and _____.
(6) False. Manage for shade *tolerant* species at higher elevations and shade *intolerant* species at lower levels.	7. To restock mixed conifer stands, generally cultivate existing advanced regeneration first. ( ) True ( ) False
(9) fill-in plant	10. To favor shade tolerant species, use ( ) clearcutting ( ) partial cutting
(12) clearcut	13. In three-storied mixed conifer stands, the overstory is usually windfirm, but the second story often is not. ( ) True ( ) False
(15) (a) 1 (b) 1,3,4 and 5 (c) 2	16. You may have to *modify* mixed conifer cutting guidelines because of _____, _____, and _____.

Guidelines for Responses to Discussion Questions

79a. There is a lot of variation in the conditions, characteristics, and potential responses of mixed conifer stands which complicates the choice of silvicultural systems and cutting methods. However, this variability also gives a manager more options than he had with pure stands.

79b. The effect of the factors are the same, but mixed conifer stands can contain up to eight different species, not one. Each species has different requirements for successful seed dispersal, germination, establishment, survival, and growth. The eight species cover a wide range of temperature, moisture, and light requirements. Mixed stands are also attacked by a greater number of insects and diseases.

79c. Wind risk is related to rooting habit, stand conditions, cutting methods, soil depth and drainage, and topographic exposure. The three zones are high, moderate, and low. High wind risk areas are on (1) all ridgetops, (2) moderate to steep upper and midslopes that face south or west, (3) valley bottoms that parallel the wind, and (4) saddles in ridges.

121a. Wind patterns in the area, the seed dispersal pattern of the species, except for aspen, and environmental factors for seed germination, establishment, and survival will determine the success or failure of the regeneration plan. (The discussion could be expanded to include visual attributes.)

121b. Clearcutting should be used for maximum aspen regeneration. The size of big game populations will influence clearcut size since large populations would require large clearcuts to reduce locally heavy browsing damage.

The size of an aspen clearcut can be "limitless" because it regenerates by sprouting. Slash disposal should be complete since the soil must be warmed to stimulate sprouting.

The size of a conifer clearcut depends on the seed dispersal characteristics of the species surrounding the opening. Some logging slash should be left to offer protection to new regeneration, and the seedbed should be scarified to expose mineral soil.

121c. For shelterwood cutting, the trees need to be uniformly spaced. For use of group selection, the trees should be in groups or clumps.

HOW WELL DO YOU REMEMBER? (cont'd)

(1) eight	2. Most mixed conifers develop following ( ) a. heavy blowdown ( ) b. wildfire ( ) c. large logging slash
(4) seed source seedbed environment	5. Major diseases often found in mixed conifer stands include _____, _____, and _____.
(7) true	8. Clearcut opening sizes will vary (more, less) in mixed conifer forests than in others.
(10) partial cutting	11. Similar topographic conditions will result in the same wind risk for all species. ( ) True ( ) False
(13) true	14. In multi-storied mixed conifer stands with below average wind risk, you can cut all age classes. ( ) True ( ) False
(16) windfirmness dwarf mistletoe insects	17. When working with individual stands within mixed conifer forests, your management approach will (change, stay the same).

Guidelines (cont'd from p. 68)

190a. For managing mixed conifer stands, you must consider each stand by itself. And to develop the individual prescriptions for the stands, you must consider the many different factors that determine their regeneration as outlined in the slide set.

190c. Favor Douglas-fir and ponderosa pine. Use some form of partial cutting, because Douglas-fir is intermediate in tolerance, and also because it will help suppress oak regeneration. If the stand is opened up too much, then it is likely that the oaks would dominate for decades. The even distribution of trees in the existing stand suggests shelterwood cutting.

Because of the possible lack of windfirmness in the second story, remove the overstory in 2 or 3 cuts over a 10- to 20-year interval. Such a prescription will leave a two-storied stand with small openings lacking regeneration. The small size of openings will assure subsequent regeneration.

190d. Since regeneration is lacking, the silvicultural system used must ensure regeneration. While the tolerant white fir and mid-tolerant Douglas-fir could be established by partial cutting on a wetter site, the dry conditions and increased solar radiation on this west-facing slope would be difficult to overcome for these mesic species. Regeneration of these two species would also be more difficult since the site is situated at their lower elevational range. Thus, the more drought-adapted, intolerant ponderosa pine should be favored. A shelterwood system with two entries should be used to provide a good seed source for prompt regeneration.

This habitat type merges into the ponderosa pine/Arizona fescue habitat type under hotter and drier gradients.

HOW WELL DO YOU REMEMBER? (cont'd)

(2) b	3. The most common type of stand found in mixed conifer forests is ( ) a. single-storied ( ) b. two-storied ( ) c. three-storied ( ) d. multi-storied
(5) trunk rot cankers dwarf mistletoe	6. In general, you should manage mixed conifer stands for shade intolerant species at higher elevations or on cool-moist sites, and for shade tolerant species at lower elevations or on warm-dry sites. ( ) True ( ) False
(8) more	9. To achieve acceptable stocking in a suitable time period when clearcutting on south slopes, you often must _____.
(11) False. Similar topography may result in *different* wind risks for different species, depending on their windfirmness.	12. To maintain an aspen overstory, you must ( ) clearcut ( ) partial cut
(14) true	15. Match each overstory with the major factors (other than windrisk and management objectives) to consider in determining prescriptions for two-storied mixed conifer stands (you may select more than one). **Overstory**: (a) aspen; (b) ponderosa pine; (c) other conifers **Major Factors**: 1. reproduction size class; 2. tree distribution; 3. stocking level; 4. density of overstory; 5. species composition
(17) change	

NOTES

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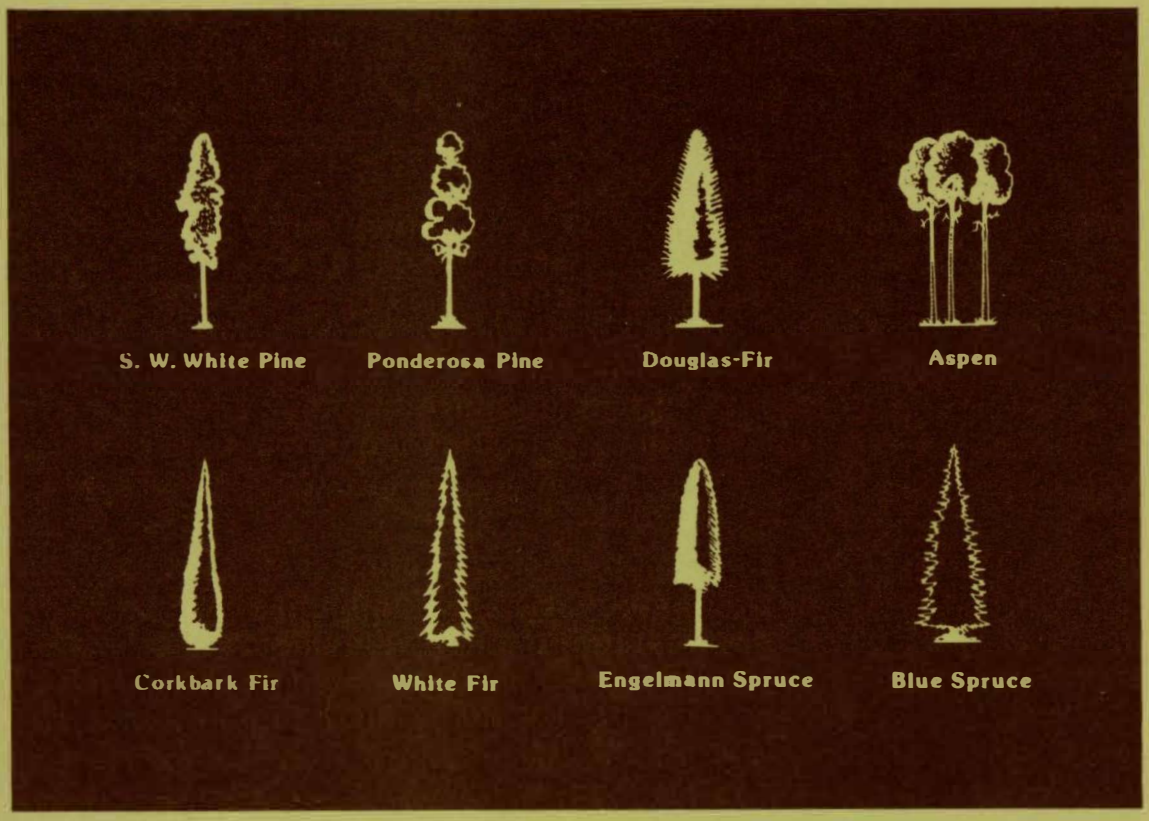
Key To Symbols for Mixed Conifer Species



Other titles in this series include the following:

Overview to Silvicultural Systems in the Central Rocky Mountains (RM-TT-1)

Silviculture of Spruce-Fir Forests in the Central Rocky Mountains (RM-TT-2)

Silviculture of Lodgepole Pine in the Central Rocky Mountains (RM-TT-3)

Silviculture of Ponderosa Pine in the Central & Southern Rockies (RM-TT-4)

Silviculture of Quaking Aspen in the Central Rocky Mountains (RM-TT-7)
(In preparation)

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